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Mariners Weather Log

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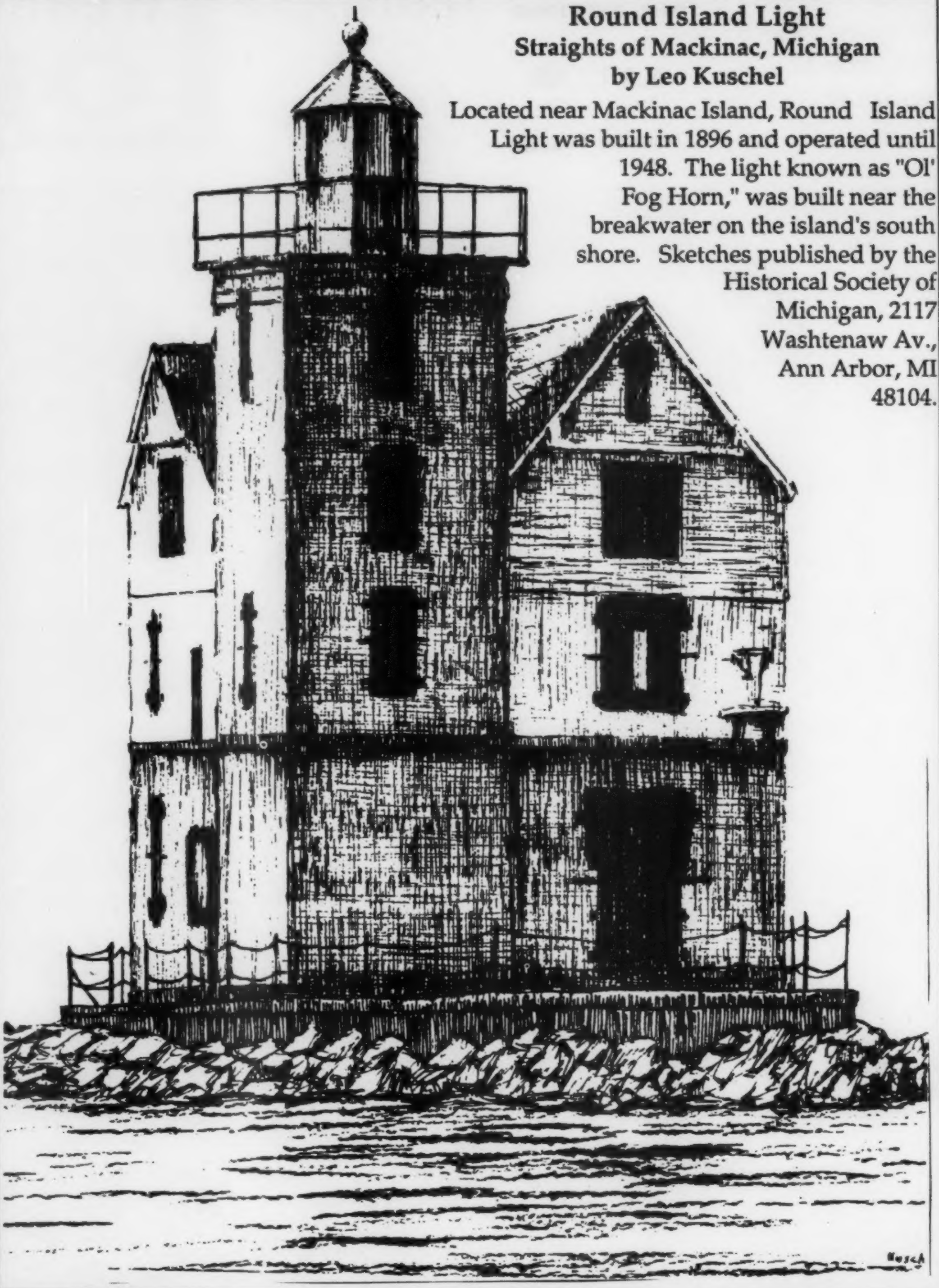
In this issue: Mystery of the *Derbyshire*, page 24

Round Island Light
Straights of Mackinac, Michigan
by Leo Kuschel

Located near Mackinac Island, Round Island Light was built in 1896 and operated until 1948. The light known as "Ol' Fog Horn," was built near the breakwater on the island's south shore. Sketches published by the Historical Society of Michigan, 2117 Washtenaw Av., Ann Arbor, MI 48104.



Mariners Weather Log

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Marine Weather Review

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Cover: The 30,000-ton ***Korean Star*** is on the rocks at Cape Cuvier, off Western Australia, in Herbie on May 20,1988 (pg 33). **Wide World Photo**

Back Cover: The Wichita Falls,TX tornado of April 10, 1979; 18,000 people were in the tornado's damage path and 44 lost their lives (pg 9). Photo **Len Hooten**.

At sea tsunamis are just a ripple but near the coast they're part of a deadly combo:

Ships, Shores

& Tsunamis

by Patricia A. Lockridge
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On July 9, 1958, the Swansons sailed into Lituya Bay, Alaska on the launch ***Badger***. They cast anchor near the Bay entrance. A little after 10:15 p.m., violent rocking of the ***Badger*** aroused Mr. Swanson. He went on deck and, in the evening light, saw the mountains heaving and shaking. An earthquake was in progress! At the head of the bay the movement dislodged a large section of rock that avalanched into the water below. The resulting explosive splash heralded the birth of a tsunami. Swanson saw the wave rise and thunder toward his boat. As the wave passed Cenotaph Island in the center of the bay, it had a height of about 50 feet.

The wave reached the launch in 4 minutes and lifted it toward the crest. With the stern forward and sinking, the launch sailed across La Chausse Spit at the mouth of Lituya Bay. Swanson looked down on the trees growing on the spit, and saw that his craft was about two boat lengths (more than 80 feet) above their tops. The flight over the tree-tops was short-lived. Immediately behind the spit, the crest collapsed in open sea and the launch hit bottom and sank. The Swansons were able to transfer to a skiff and were soon picked up by a fishing vessel. Aerial photographs, showing La Chausse Spit devoid of its former tree cover, corroborated Swanson's account.

The photograph at left,shows the results of the July earthquake with the flooded areas in white. The earthquake-induced rockslide generated a wave that surged 1720 feet up the mountainside. **NOAA photo.**

Tsunamis, incorrectly called tidal waves, have been responsible for millions of dollars in property damage in the United States and its territories.

They present a special hazard to shipping, fishing, and recreational craft.

In November of 1935 a tsunami in Hawaii ran many fishing vessels and yachts onto dry land at Hilo. A November 1952 tsunami threw boats ashore throughout the islands. At Port Graham, AK, in October 1883, all the fishing boats were beached, carried out to sea, and finally run aground. The March 1964 tsunami in Valdez, AK demolished the waterfront facilities and destroyed the entire fishing fleet that was in the harbor.

"Tsunami" is a Japanese word meaning "harbor wave." As the name suggests, these waves, although formed in the open sea, confine their effects to coastal areas. A large mass of earth on the bottom of the ocean drops or rises in an earthquake, explosion, landslide, or volcanic eruption. The movement of the ocean floor displaces the column of water directly above it. The resulting wave or series of waves travel through the water at speeds up to 600 miles per hour. These tsunamis are nearly undetectable far out from land, but as they approach shallow water, tsunamis trade speed for height. Heights may reach 100 feet or more as waves crest onshore. Some tsunamis, on the other hand, are barely measurable.

On March 27, 1964, Ted Pederson stood on the dock to which his oil tanker, the ***Alaska Standard*** was

At right is the result of the tsunami of March 27, 1964. The scene is Seward, AK at the north end of Resurrection Bay. Fishing vessels litter the shoreline. This tsunami was responsible for 107 deaths in Alaska, 4 in Oregon and 11 in Crescent City, CA. Damage on the West Coast was estimated at more than $100 million.

Tsunami Data

Computer systems are constantly being upgraded to handle data quickly and efficiently. Refined historical data are also increasingly useful in predicting future events. The U.S. National Geophysical Data Center/ World Data Center A for Solid Earth Geophysics has developed data bases to further tsunami research. These sets of data include marigrams (tide gauge records), wave damage photographs, source data, descriptive material, and a tsunami wall map. A digital file contains information on methods of tsunami generation, location and magnitude of generating earthquakes, tsunami size, event validity, and references. The data can be used to describe areas most likely to spawn tsunamis and the location along shores that experience amplified effects from tsunamis.

This data collection began with the Historical Tsunami Data Base, which consisted of about 1,450 events compiled by Doak Cox of the University of Hawaii. Additional information was added from National Geophysical Data Center files for earthquake epicenters, magnitudes, and depths. Tsunami effects including wave heights, damage, travel times, arrival times, and number of deaths were added from several sources including the *Catalogues of Tsunamis of the Western and Eastern Coasts of the Pacific Ocean* by Soloviev and Go.

Currently the data base consists of about 6,600 records, and represents events from 49 B.C. to present. Included are data on tsunamis in the Mediterranean and Caribbean Seas and the Atlantic, Indian, and Pacific Oceans. In-depth information is also available for Hawaii, Chile, Peru, Alaska, and the west coast of the United States. Other in-depth regional studies will be completed in the future.

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tethered. He was on hose watch when he felt a tremor transmitted from shore to dock. He realized an earthquake was occurring. Thirty seconds after the initial jolt, the shaking became very violent along the waterfront. Pederson saw his oil tanker buck and slam against the dock. Turning, he began to sprint along the dock toward the shore and safety. He ran about 100 feet when all the pipelines leading from the beach to the dock broke, causing oil to gush into the air. As the oil company facilities exploded in a ball of fire, the ***Alaska Standard*** flew 25 feet into the air and fell back on the dock.

The collapse of the dock threw Pederson into the turbulent water about 20 feet below the deck of his ship. He struggled to remain afloat in the water where seconds earlier the oil company dock had been. He looked over his shoulder in time to see a huge wave filled with debris engulf him. Something struck him on the back of the head and knocked him unconscious. When he came to, he found that the wave had plucked him out of the water and deposited him back on his ship. Pederson was 8 feet above the deck on the ***Alaska Standard***"s catwalk, wet but safe.

In August of 1868 the U.S. Navy ship ***Wateree*** anchored about a quarter mile from the shore of Arica, Peru. At about 4:00 p.m., Rear Admiral Billings felt the ship tremble violently. On deck, Billings and the crew discovered that the shaking was due to an earthquake. As they watched, the town of Arica crumbled to dust in a matter of

U. S. Navy

This eerie scene was caused by a tsunami that was generated by an earthquake on August 8, 1868 in Arica, Chile. After it was finished it left the ***America****, Peruvian* ***Man of War****, and the* ***U.S.S. Wateree*** *some 2 miles inland.*

seconds. Seeing a few survivors crawling out of the ruins, the ***Wateree*** dispatched a landing party to supply aid. Unfortunately, incoming ocean swells dashed the launch to pieces against rocks in the harbor, killing one man.

Following another earth tremor, the water rapidly withdrew from the harbor leaving the flat-bottomed ***Wateree*** high and dry. The returning sea lifted the vessel from the sandy sea floor. The keel-bottom boats in the harbor, however, were capsized and destroyed as the incoming waves tumbled them about. Four hours later, in early evening, the crew noticed a thin line of phosphorescent light sweeping towards them from the sea. As the light grew rapidly closer, the men realized that a tsunami was about to engulf them.

The wave surged on the coast, submerging the U.S. ship. Miraculously, the flat bottom allowed it to fight back to the surface and ride the wave inland. After a time, movement ceased. The light of dawn revealed that the ***Wateree*** was two miles inland at the foot of the Andes. If the wall of water had carried them a couple of hundred feet further, the ship would have smashed against a mountainside.

Although most tsunamis develop in the Pacific Basin, they can occur elsewhere with equal devastation. The ***U.S.S. Monongahela*** was anchored in the harbor of Frederiksted on the west coast of St. Croix, Virgin Islands on November 29, 1967. The first indication of danger was a violent trembling of the ship in completely

*This tsunami at Hilo, HI on April 1, 1946 was the most destructive in Hawaiian Island history. It was responsible for more than 170 deaths and led to the establishment of a tsunami warning system. The man in the photo was one of the 90 people in Hilo, who lost their lives. The picture was taken from the **Brigham Victory**.*

calm weather. The water receded rapidly from the shore. The current changed almost immediately and drove the ship toward the beach with a force that drew the bolts from the kelson. Within a few yards of the beach, the reflux of tide and a light breeze appeared to offer a reprieve to the shore-bound ship. However, the returning wave was 25 to 30 feet high. It picked up the ***Monongahela*** and carried her over the warehouse into the first street fronting the bay. The reflux of this wave carried her back toward the beach leaving her keeled over at an angle of fifteen degrees. Commodore Bissel reported that the hull of the ship had not sustained injury. Although there was damage to the keel, the propeller, shaft, and rudder, he believed that the ship could be refloated. The task was completed in about six months and the ***Monongahela*** left Frederiksted on May 20, 1968.

Ships and boats at sea or away from harbor areas escape damage. Perhaps the most dramatic example of this occurred in Japan in June of 1896. In this event the fishermen who had gone to sea were among the few survivors of a tsunami that took more than 27,000 lives. When they returned on the morning following that disaster, they saw a sea strewn with the debris of homes and corpses. Heaps of ruins or bare expanses were all that remained where coastal villages and cities had been. The tsunami had passed beneath the fishing boats undetected but had devastated the coastal areas.

This event illustrates the best defense for boats and ships anchored in

NOAA Local Warning System

Vast areas of the Pacific coastline, left unprotected by expensive regional systems, should benefit from the development of a high-tech tsunami warning system. Using readily available technology and a NOAA weather satellite this system was installed at Valparaiso, Chile, a Pacific coast city, which has lost more than 1,500 people to tsunamis since 1900. This system can be installed for as little as $20 thousand compared to $1 million to install a regional setup.

The system is designed to detect 7.0 scale undersea earthquakes 50 miles from shore and 6.2 scale earthquakes 21 miles out. Most of Valparaiso's fatalities have been from tsunamis within 60 miles of the coast.

When an earthquake of 7.0 or more on the Richter scale occurs within 60 miles of the Valparaiso coast, an accelerometer is tripped, transmitting an alert through the GOES satellite. A computer simultaneously sends emergency messages to a warning center in Valparaiso, to the Pacific Tsunami Warning Center and to water level sensors in Valparaiso Harbor. A computer in the city automatically warns public safety offices and begins monitoring the water level sensors. They, in turn, transmit tsunami wave information back through the satellite system.

harbors when a large earthquake occurs. Ships should attempt to leave the harbor area and reach the open seas. The amount of time elapsing before the arrival of the tsunami is dependent on the distance to the tsunami-generating area (earthquake epicenter.) Areas prone to tsunami damage have established local and regional tsunami warning systems to warn ships and coastal areas of the impending dangers.

On April 1, 1946 a tsunami was generated in the Aleutian Islands that caused some damage in the sparsely-settled Aleutians and more than $26 million in property damage in the Hawaiian Islands. Following this event the U.S. Coast and Geodetic Survey provided a tsunami warning system for the Hawaiian Islands. The following capabilities are necessary for such a warning system: the ability to detect rapidly and accurately the location of each earthquake; the ability to determine the actual existence of a tsunami; and the ability to calculate the expected time of arrival of the tsunami. This process requires an hour or less, and gives adequate time to warn of tsunamis that require 4 to 15 hours to reach the Islands. The system begins to function only when an earthquake of magnitude 6.5 or larger, anywhere in the Pacific Basin, triggers the earthquake alarm.

In 1965 the United States, in cooperation with the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Intergovernmental Oceanographic Commission (IOC), expanded its existing Tsunami Warning Center in Honolulu to become the headquarters of the International Pacific Tsunami Warning System. Today the Pacific Tsunami Warning Center (PTWC) at Ewa Beach, near Honolulu, is operated by the U.S. National Weather Service. Twenty-three nations in the Pacific now cooperate in the warning system. The system makes use of 69 seismic stations, 65 tide stations, and 101 dissemination points scattered through the Pacific Basin.

PTWC requests data from observatories in the system to determine the epicenter and magnitude of the earthquake. If the earthquake has a magnitude of 7.5 or larger (7.0 or larger in the Aleutians), and is located where a tsunami could be generated, PTWC issues a tsunami watch. It requests participating tide stations in the area of the earthquake to monitor their gauges. If one of the tide stations in the area reports unusual tidal activity, the tsunami watch is upgraded to a tsunami warning. PTWC calculates the travel times and transmits the warning to the disseminating agencies who then relay the message to the public. If reports from tide stations show that the tsunami is too small to cause problems, PTWC cancels the watch or warning.

PTWC is most effective in warning against tsunamis that affect the entire Pacific Basin. Warnings for local and regional tsunamis, occurring within 45 minutes to 1 hour of the earthquake event, cannot be effectively disseminated by PTWC. Therefore, the United States operates regional warning systems for Hawaii, Alaska and the West Coast. Japan, USSR, France, Polynesia and Chile operate similar systems.

In areas near the earthquake epicenter, the earthquake itself is the best warning. Strong shaking of the earth lasting a minute or more is an urgent warning for people to evacuate coastal areas immediately. Such shaking is also a signal for ships' captains to get the ship under power and away from the shore. Turning the bow of the ship toward the wave may save the ship from being capsized by the tsunami. In such instances education is the best defense against the tsunami threat.

However, new technology continues to improve the warning system process. An updated warning system is being implemented that transmits real-time data to the PTWC from shore-based seismic and tsunami sensors using synchronous meteorological satellites. Future additions to the PTWC may include ocean bottom sensors placed in the travel path of tsunamis to confirm that an earthquake has generated a tsunami. Use of these sensors should help to eliminate unnecessary warnings. They will provide scientists with critical data about the wave when it is undisturbed by shoaling processes.

The combination of ships, shores, and tsunamis can be deadly. However, better tsunami warning systems and increased awareness by navigators can mitigate the effect of this hazard.

A Tornado Sampler

While tornadoes are more at home on land than sea, they do affect inland waterways and occasionally the Gulf and southeast U.S. Coasts. Sometimes they move from land to water and become "tornadic waterspouts" such as the one that hit Miami's Dinner Key in 1968. It picked up a 5–ton houseboat and impaled it on an 8–foot wooden piling some 100 feet from its berth. This guide, however, is designed to cover the dangerous Midwest tornado and would be most applicable to those who sail the Great Lakes, Mississippi River and other bodies of water in this section of the United States.

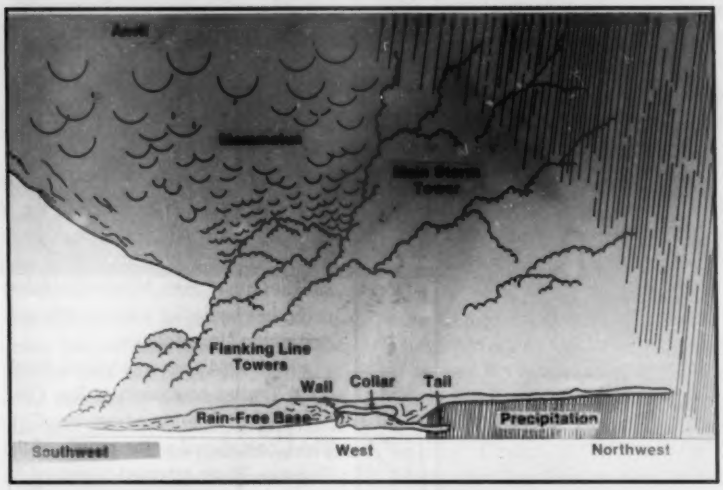
In June 1984 a severe tornado developed 3 miles southwest of Bay City, MI. It lifted as it moved into Bay City. The Coast Guard at the mouth of the Saginaw River reported a gust of 81 miles per hour while a sailboat capsized on Saginaw Bay, where it touched down again. It reached maximum intensity as it moved onshore at the south edge of Bay Port. Maximum intensity for this type of tornado is winds of 158 to 206 miles per hour. It is capable of overturning trains, lifting heavy cars off the ground and uprooting most trees in a forest. This particular tornado did destroy 4 homes, 21 barns, 5 silos and 12 outbuildings.

All thunderstorms are capable of producing tornadoes. In coastal areas, waterspouts and weak funnels frequently form in areas of shower activity. While these are dangerous, they are usually not preceded by the cloud structures described in the guide. Strong to violent tornadoes are usually associated with the Tornadic Thunderstorm. Other significant tornadoes do occasionally occur with Squall Line Thunderstorms.

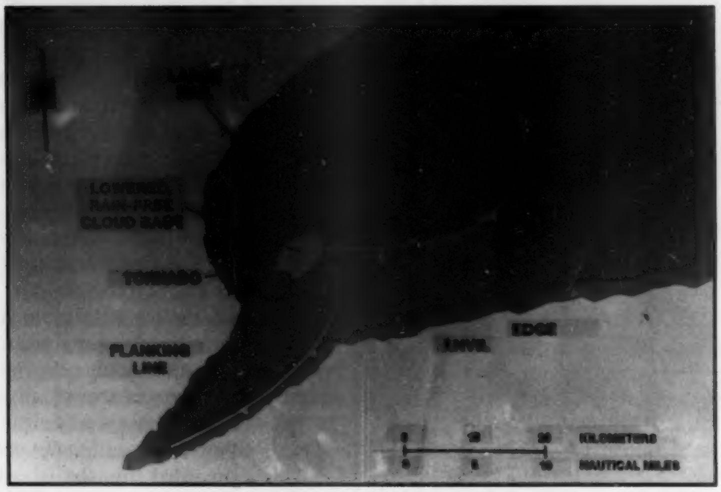
The information contained in this guide was condensed from the National Weather Service's *Spotter's Guide for Identifying and Reporting Severe Local Storms*. It is intended mainly to assist those observers who participate in the MAREP program as well as those who sail the U.S. inland waterways and the Great Lakes. The technical terms are explained in the text or glossary.

Tornadic Thunderstorm

These thunderstorms are usually separated from other thunderstorms or may even be isolated. This separation allows them to feed upon warm moist air from miles around.



Representation of a tornadic thunderstorm as you might see it when located east of the storm, looking west. The main updraft of warm moist air is entering the storm at the cloud base below the Main Storm Tower. Strong winds aloft are blowing from the southwest to northeast. Air in the upper portion of the updraft eventually becomes colder than the surrounding air. At this level, the cloud spreads out rapidly, forming an Anvil Cloud. As precipitation begins to occur downdrafts are created. The Flanking Line Towers, Collar Cloud, and Tail Cloud are explained in the glossary. The three features of primary importance are the Rain Free Base, Wall Cloud, and Precipitation Area.



This is a view of the same storm and its associated weather from above. The intense updraft, which is rising out of the drawing, is located within the main storm tower as shown by scalloped lines in a semicircle surrounding the medium gray area. The downdraft air sinks to the ground in the precipitation area, mainly north and northeast of the updraft. A second downdraft forms just southwest of the updraft. This is the area, near the intersection of the updraft and this "rear-flank" downdraft, where the tornado is most likely to occur. Large hail is likely to fall just outside the updraft core, mainly northeast of the updraft. Tornadoes may also form along the Gust Front and Flanking Line; these are usually weak and short-lived.

This view is west of the storm looking east-southeastward; the storm is moving to the left. Heavy rain to the left tells us where a main downdraft is located. The Rain Free Base extends from under the Main Storm Tower (which is tilted slightly to the left by the upper level winds) to the Flanking Line Towers. The lower cloud base near the center is a Wall Cloud. It is usually in the southwest portion of the storm within several miles of the rain area. Not all Wall Clouds rotate but when they do it usually precedes significant tornado development from minutes to over an hour.

The Tornado

Tornadoes vary greatly in appearance and intensity, ranging from the violent type (back cover) to weak, short-lived ones that last only a few seconds. In addition, a tornado's appearance frequently changes during its life cycle.

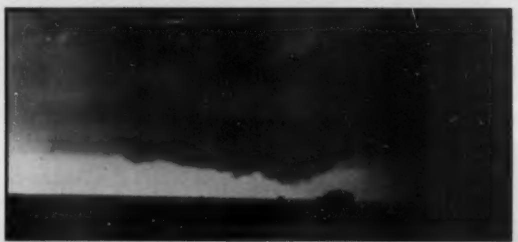
This photo shows a multiple vortex tornado composed of several small but intense vortices, which revolved around a common center. These small vortices may develop and dissipate very quickly.

At times, rainfall is drawn into the tornado's circulation, making it very difficult to see. While this is common in the southeast United States, it is not limited to that area as illustrated by the Kansas tornado at left.

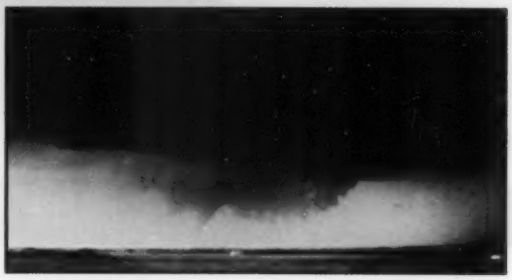
At left, we see a tornadic dust whirl. It should not be confused with a dust devil, which usually occurs on nearly cloudless, warm days with light winds. The first stage of tornado development is often a dust whirl at the ground with or without a funnel aloft. This tornadic dust whirl did not develop beyond this initial stage. It is common for flanking line dust whirls to form along the gust front; these generally remain weak and short-lived.

The Life Cycle of a Tornado

You are looking west (right) and can see the typical pattern: Rain Free Base, Wall Cloud, and Precipitation Area. The Wall Cloud is located in the southwest quadrant of the storm, and formed 30 minutes prior to the tornado.



What appears to be a funnel cloud is visible under the left portion of the Wall Cloud (above). In fact, this is a tornado because damage was occurring at the ground even though it is too far away to see the surface debris. In such a situation, this would properly be reported as a funnel cloud.



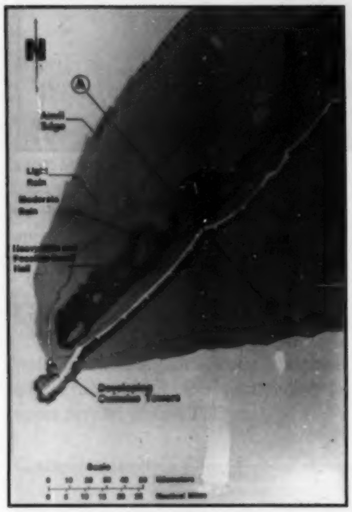
Above, the circulation becomes visible all the way to the ground. The thin, "needle-tipped" shape is common for a tornado in this early stage.

The tornado reaches its mature stage to the left with its width at the surface expanding to 1/4 mile. Note the Tail Cloud forming to the right.

Above we have changed position and are looking southeastward as the tornado moves away from the town of Union City, Oklahoma. The tornado is shrinking rapidly into the "rope stage," but is still very destructive. During the latter portion of a tornado's life, it is common for it to decrease in size (not necessarily in intensity) and become increasingly tilted.

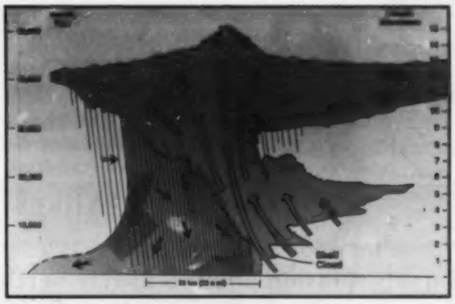
Squall Line Thunderstorms

These thunderstorms often generate strong straight–line winds. Hail may occur but it is usually smaller than that occurring in tornadic thunderstorms and tornadoes are less frequent. As the squall line passes overhead, gusty winds and a sharp drop in temperature can be expected.



Left is a view of a squall line from above. Precipitation is shown in the central area, the gust front is the white line with teeth, and the anvil edge is in light gray. The strongest winds usually occur a few minutes after the gust front passage, just before or just after rain and hail begin. If tornadoes occur, they are generally weak, short-lived, and are found along the gust front.

Occasionally, a tornadic thunderstorm will develop in association with a squall line, most often on the south end or ahead of it. The most distinctive cloud associated with the squall line is the Shelf Cloud. It is usually located above the squall line gust front. A tornadic thunderstorm or even an isolated non-severe thunderstorm may at times develop a shelf cloud associated with its gust front. Below is a vertical cross section of the squall line from point A to B. Note that the squall line thunderstorm has a significantly different structure than the tornadic thunderstorm. The squall line is moving from left to right. Updrafts form a nearly continuous curtain along the leading edge above the gust front. Downdrafts are located in the precipitation area to the rear. Thus, the updraft-rainy downdraft orientation is reversed from that of the tornadic thunderstorm.



Here you are looking westward at three layers of cloud near the south end of a gust front. The lowest band is a shelf cloud—wedge-shaped and smooth, sometimes appearing layered. Upward motion is along the leading edge and downward motion along the trailing edge of the shelf cloud. The cloud base behind the gust front is often very turbulent.

Less common than the shelf cloud is a roll cloud. It is seen in a detached tube shape and often appears to rotate slowly about a horizontal axis. Like the shelf cloud, it may indicate the leading edge of a zone of strong straight-line winds. Because of the horizontal rotation, it may be mistaken for a tornado.

Virga or rain shafts are often reported as tornadoes. Above (left) we see a developing rain shaft, which is fuzzy in appearance. An intense rain column (above, right) can be more difficult. Although it looks similar to a violent tornado, its edges are much less distinct.

Tornado Look-Alikes

In these examples, and for all tornado look-alikes, the key is to: **Look for organized and sustained rotation about a nearly vertical axis.**

Mammatus clouds, as seen to the left, are often mistaken for tornadoes. While mammatus often accompany severe thunderstorms, they are not severe in themselves and may also accompany non-severe thunderstorms. The feature most often mistaken for a tornado is a scud cloud. These are ragged, low cloud fragments which usually are not attached to the cloud base. When the scud is attached to the cloud base (right), it is very difficult to distinguish it from a wall cloud or tornado.

National Weather Service
Storm Spotter's Glossary and Supplemental Guide

Accessory Clouds
Clouds that are dependent on a larger cloud system for development and continuance. Accessory clouds associated with the thunderstorm include roll, shelf, mammatus, and wall clouds.

Anvil
The spreading of the upper portion of a cumulonimbus cloud into an anvil-shaped plume usually of fibrous or smooth appearance. Strong or severe thunderstorms often have thicker anvils with the side and bottom having a cumuliform or slowly boiling appearance in the immediate vicinity of the parent cumulonimbus.

Collar Cloud
Frequently used as a synonym for a wall cloud although it actually is a generally circular ring of cloud surrounding the upper portion of a wall cloud.

Cumulonimbus Cloud
The parent cloud of a thunderstorm, it towers above ordinary cumulus clouds. Strong or severe storms often have a more sharply outlined "hard" appearance with relatively rapid rising motions visible. The cloud's upper portion includes the anvil. Accompanying precipitation is often heavy and the lightning and thunder that is usual with these clouds leads to the popular names of thunderhead or thundercloud.

Cumulus Cloud
A column of rising air that has condensed into a dense, nonfibrous cloud with distinct outlines, appearing much like a rising mound, a dome or cauliflower. The base of the cloud is relatively flat and dark, while the tower is usually white and sunlit. The cumulus cloud is the first stage of a developing thunderstorm, although most cumulus do not form thunderstorms.

Downdraft
A column of generally cool air that rapidly sinks to the ground, often accompanied by precipitation in showers or thunderstorms. Areas of downdraft usually contain little cloud.

Flanking Line
A line of cumulus connected to and extending outward from the most active portion of a parent cumulonimbus, usually found on the southwest side of the storm. This line has roughly a stair step look, with the taller clouds adjacent to the parent cumulonimbus. It is frequently associated with strong or severe thunderstorms.

Flash Flooding
Flooding that develops very quickly on streams and river tributaries often as a result of thunderstorms. Sometimes its onset comes before the end of heavy rains. There is little time between the detection of flash flood conditions and the arrival of the flood crest. Swift action is essential to the protection of life and property.

Front
A transition zone between two differing air masses. Basic frontal types are (1) Cold Front — cooler air advances replacing warmer air: (2) Warm Front — warmer air advances replacing cooler air: (3) Stationary Front— warmer air meeting cooler air with neither air mass moving appreciably. Thunderstorms can accompany any of these fronts. However, fronts are not necessary for thunderstorm development.

Funnel Cloud
A funnel-shaped cloud extending from a towering cumulus or cumulonimbus base. It is associated with a rotating air column that is not in contact with the ground. The cloud is a tornado if ground-based debris or a dust whirl is visible below the funnel aloft.

Gust Front
The leading edge of the thunderstorm downdraft air. The gust front is prominent beneath the rain-free base and on the leading edge of an approaching thunderstorm. It is usually marked by gusty, cool winds, and often blowing dust. The front often precedes precipitation by several minutes. The shelf or roll cloud sometimes accompanies the gust front, especially when it precedes a line of thunderstorms.

Hail
Precipitation in the form of balls or clumps of ice, produced by thunderstorms. Severe storms with intense updrafts are the most likely large hail producers.

Hook Echo
A radar pattern sometimes observed in the southwest quadrant of a tornadic thunderstorm. Appearing like the number six, the hook echo is precipitation aloft around the periphery of a rotating column of air 2-10 miles in diameter. The hook echo is often found in a local area favorable for tornado development. However, many tornadoes occur without a hook echo and not all hook echoes produce tornadoes.

Lighting
All of the various forms of visible electrical discharge caused by thunderstorms. Severe thunderstorms usually have very frequent and sometimes nearly continuous lightning. However, non-severe thunderstorms also contain frequent and vivid electrical displays, while some severe storms are accompanied by little lightning.

Mamma Clouds
Also called mammatus, these clouds appear as hanging, rounded protuberances on the under surface of a cloud. With thunderstorms, mammatus are seen on the underside of the anvil. These clouds do not produce any type of severe weather, although they often accompany severe thunderstorms.

Precipitation Shaft
A visible column of rain, hail or both falling from a cloud base. When viewed against a light background, heavy precipitation appears dark gray, sometimes with a turquoise tinge. This turquoise tinge has been commonly attributed to hail but its actual cause is unknown.

Rain-Free Base
A horizontal, dark cumulonimbus base that has no visible precipitation beneath it. This structure usually marks the location of the thunderstorm updraft. Tornadoes most commonly develop (1) from wall clouds that are attached to the rain-free base, or (2) from the rain–free base itself. This is particularly true when the rain-free base is observed to the south or southwest of the precipitation shaft.

River Flood
Usually occurs on rivers, after flash flooding has occurred on streams and

tributaries. River floods develop and reach their peak more slowly than flash floods. In many cases, the river flood peak occurs after the rain has ended.

Roll Cloud

A rare, low-level, horizontal, tube-shaped accessory cloud detached from the cumulonimbus base. If present, it is located along the gust front and frequently observed on the leading edge of a line of thunderstorms. The cloud will appear to be slowly "rolling" about its horizontal axis. Roll clouds do not produce tornadoes.

Scud Clouds

Low cloud fragments often seen with and behind thunderstorm gust fronts. Ragged and wind torn they are not usually attached to the thunderstorm base. They do not produce severe weather. In some cases, when attached to the thunderstorm base, they can be mistaken for wall clouds or tornadoes.

Severe Thunderstorm

A thunderstorm that goes from the mature to the severe stage before dissipating. Severe thunderstorms are most efficient "machines" because the updraft remains strong for a long time. They occasionally contain rotation on a broad scale. Because of its structure, the severe storm may last hours beyond the lifetime of a normal thunderstorm while producing large hail, high winds, torrential rain, and possibly tornadoes. A thunderstorm is classified as severe if 50–knot winds are measured, 3/4 inch or larger hail occurs, or funnel clouds or tornadoes develop.

Straight Winds

Winds associated with a thunderstorm, most frequently found with the gust front. They originate as downdraft air reaches the ground and rapidly spreads out, becoming strong horizontal flow. Damaging straight winds, although relatively rare, are much more common than tornadoes.

Shelf Cloud

A low-level horizontal accessory cloud that frequently appears to be wedge-shaped as it approaches. It is usually attached to the thunderstorm base and forms along the gust front. The leading edge of the shelf is often smooth and at times layered or terraced. It is often seen along the leading edge of an approaching line of thunderstorms, accompanied by gusty straight winds as it passes overhead and followed by precipitation. The underside is concave upward, turbulent, boiling, or wind-torn. Tornadoes rarely occur with the shelf cloud.

Squall Line

Any line or narrow band of active thunderstorms. The term is usually used to describe solid or broken lines of strong or severe thunderstorms.

Tail Cloud

A low tail-shaped cloud extending outward from the northern quadrant of a wall cloud. Motions in the tail cloud are toward the wall cloud with rapid updraft at the junction of tail and wall cloud. This horizontal cloud is not a funnel or tornado.

Thunderstorm

A local storm (accompanied by lightning and thunder) produced by a cumulonimbus cloud, usually with gusty winds, heavy rain, and sometimes hail. Non-severe thunderstorms rarely have lifetimes over 2 hours. A typical, non-severe thunderstorm life cycle consists of three stages (1) Cumulus Stage — warm, moist air rises (updraft) and condenses into tiny water droplets which make up the visible cloud. (2) Mature Stage — the cloud grows above the freezing level; precipitation forms and becomes heavy enough to fall back to earth. This precipitation generates cool air which also sinks back to earth with the precipitation. (3) Dissipation Stage — cool rain and downdraft spread throughout the storm replacing the updraft which is the lifeblood of the thunderstorm. The visible cumulonimbus cloud becomes softer in appearance, less distinctly outlined and dissipates, sometimes leaving only the high anvil cloud as the storm rains itself out.

Tornado

A violently rotating narrow column of air in contact with the ground and extending from a thunderstorm base. The tornado is most often found in the southwest quadrant of the storm, near the trailing edge of the cumulonimbus cloud. Tornadoes and funnel clouds are usually pendant from (1) wall clouds or (2) directly from the thunderstorm base, within a few miles to the southwest of the precipitation shaft. The spinning motion of a tornado is most often left to right on the front side and right to left on the backside (counterclockwise). Tornadoes have been called twisters and cyclones, but these words are all synonyms for the most violent storm on earth, with estimated wind speeds up to 300 mph.

Updraft

Warm moist air which rises and condenses into a visible cumulus or cumulonimbus cloud. Once the cloud forms, it depends on the updraft for continuance and further development.

Virga

Wisps or streaks of rain falling out of a cloud but not reaching the earth's surface. When seen from a distance, these streaks can be mistaken for funnels or tornadoes.

Wall Clouds

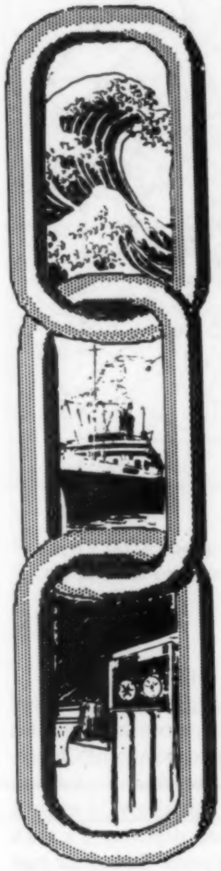
A local and often abrupt lowering of a rain-free cumulonimbus base into a low-hanging accessory cloud, from 1 to 4 miles in diameter. The wall cloud is usually situated in the southwest portion of the storm below an intense updraft marked by the main cumulonimbus cloud and associated with a very strong or severe thunderstorm. When seen from within several miles, many wall clouds exhibit rapid upward motion and rotation in the same sense as a tornado, except with considerably slower speed. A rotating wall cloud usually develops from a few minutes up to possibly an hour before tornadoes or funnel clouds. Spotters should key on any lowering of the cumulonimbus base as suspect wall cloud particularly when it is located southwest of the precipitation shaft. Wall clouds should be reported. Note: Sometimes other low-hanging accessory clouds are mistakenly identified as wall clouds.

Warning

(Issued for tornadoes, severe thunderstorms, flash floods, river floods.) A warning is issued when severe weather has already developed and has been reported by spotters or indicated by radar. Warnings are statements of imminent danger and are issued for relatively small areas near and downstream from the severe storm or flood.

Watch

(Issued for tornadoes, severe thunderstorms, flash floods). A watch identifies a relatively large area in which flash floods or severe storms might occur. Watches are often issued before any severe weather has developed. Severe thunderstorm and tornado watches usually include an area 140 miles wide by about 200 miles long. The watch is only an indication of where and when the severe weather probabilities are highest, and should not be confused with a warning.



the Vital Link

"The weather reports received from vessels at sea have always been essential to the success of our mission of recording, analyzing, forecasting and summarizing the weather."

— F.W. Reichelderfer
former Chief of U.S. Weather Bureau

— by Vera M. Gerald
NOAA
Camp Springs, MD

While the oceans cover approximately seventy percent of the earth's surface, the number of land weather reports is five times larger than those from the sea; this despite the tremendous influence the oceans have on global weather and climate. In addition marine surface observations tend to cluster along the major shipping lanes. Since the marine data base is relatively sparse, maximum use must be made of this valuable resource in forecasting as well as studies of atmospheric and oceanographic processes.

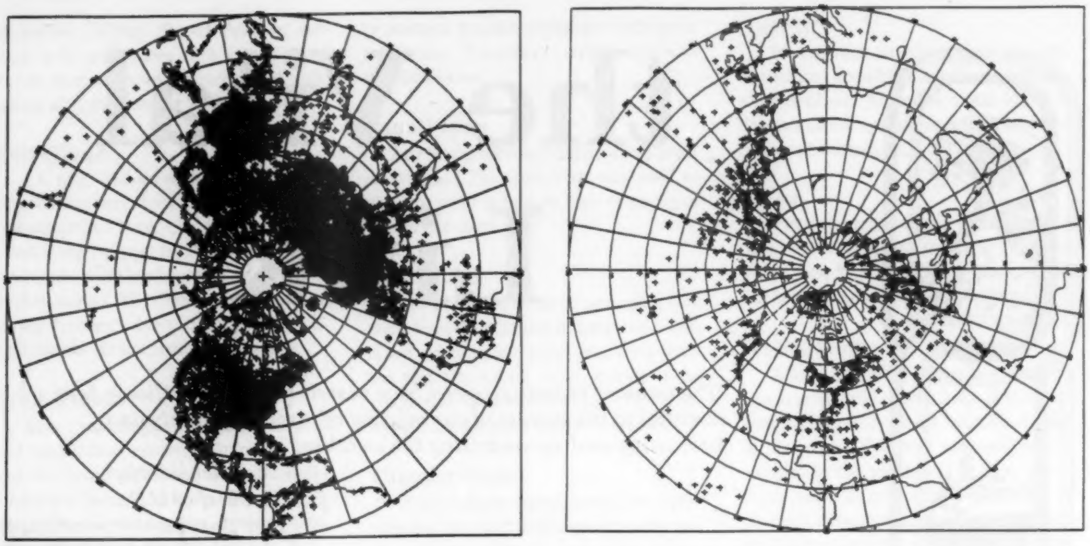
The National Meteorological Center (NMC) receive real-time synoptic marine data from various platforms. All data that are available by the scheduled model run are used to help produce initial analyses for use within the suite of operational numerical prediction models of NMC.

"Marine surface collection systems must be checked to ensure maximum availability of data."

In view of the necessity for a real-time synoptic marine data base, it is important to ensure that all data arrives in time to be used within NMC's analyses and quality controlled in real time to maximize their impact on forecasts. Therefore, systems collecting surface marine reports must be checked to ensure maximum availability of data. As a first step, surface marine platforms, observations parameters, and receipt time of all data received at NMC are being monitored. In addition, quarterly ship track summaries of all Voluntary Observing Ships (VOS) are compiled. These summaries are routinely provided to the Office of Ocean Services and the Marine Observing Program of the Observing Systems Branch to seek avenues to increase real-time data coverage over the oceans and improve receipt time at receiving centers.

Synoptic marine data are stored on a 10-day rotating file called, NWS.NMC.ARKV.SFCSHP. This data set consists of all observations reported by weather stations and marine reporting stations (MARS). These reports are transmitted to NMC by coastal radio stations, the Global Telecommunication System (GTS) and the GOES data collection network. The data are sorted by call sign, day and time, and saved on tape once a week.

During 1986, NMC received 2,209,566 synoptic marine observations. Ships remain the dominant data



These two northern hemisphere polar charts represent a comparison between surface land and marine observations. At left is a plot of the 0000 UTC surface land observations received by 0225 UTC on November 20, 1987—5106 obs. To the right are the 0000 UTC surface observations received from marine platforms by 0231 UTC on that same day—968 obs.

source (56.2%). Fixed buoys represent less than 7 percent of the total. The second largest contribution to the surface marine data base comes from drifting buoys (22.0%). The timely dissemination of surface marine data is vital to improving and updating NMC's analyses and forecasts. Time-delay is the interval between the time an observation is taken and the time it is received at NMC.

" Presently less than 50 percent of ship data are received within one hour."

Surface marine reports transmitted directly through the GOES network to NMC are delivered in a timely fashion. Time-delay tabulations for FBUOYS, OWS, and MARS show that 93 to 96 percent of the data arrive within one hour or less. However, most ship reports are transmitted during the radio officer's watch by radio message to a coastal receiving station. Because of economic constraints, shippers have been forced to reduce the number of radio officers. The results have been a continued reduction in the timely transmission of ship reports. Presently, less than 50 percent of ship data are received within one hour.

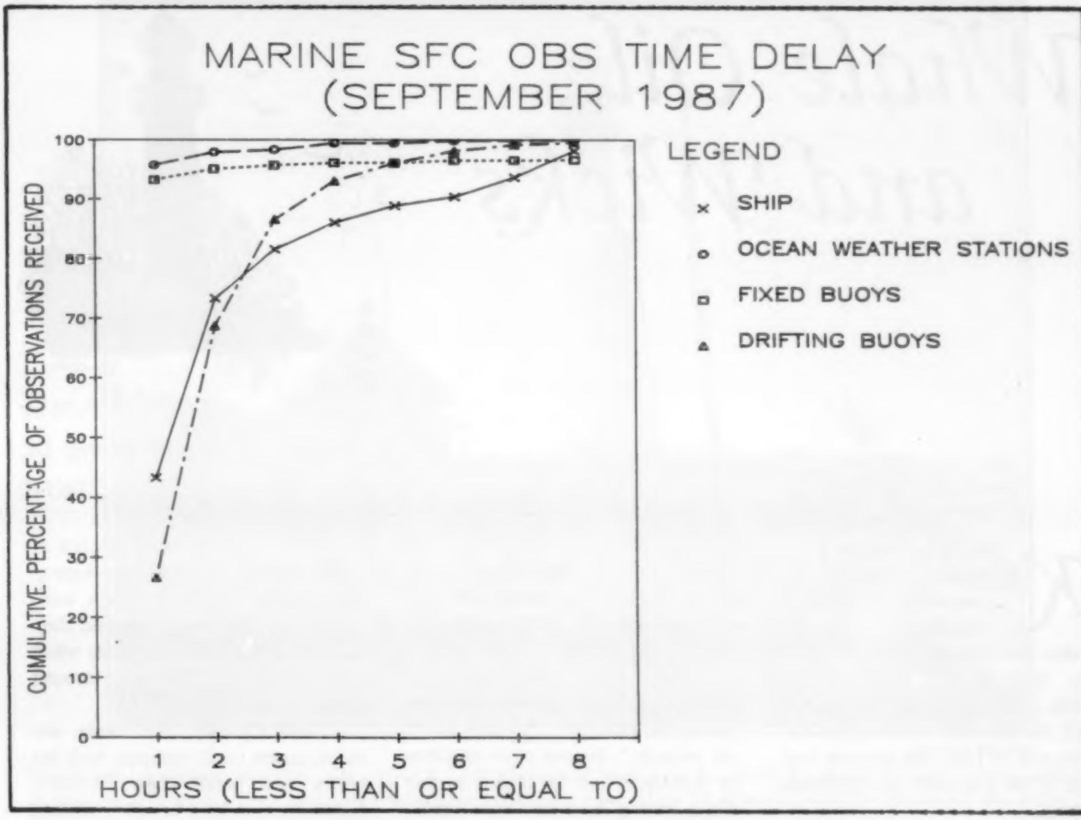
The amount of drifting buoy data arriving within one hour is low, less than 27 percent, due to the data processing system; i.e., DBUOYS reports are collected by polar orbiting satellites and transmitted via Service Argos to the Argos data processing center in Toulouse, France; then the data must be decoded from engineering to metric units, compiled into the standard World Meteorological Organizational (WMO) format, and finally entered onto the GTS network.

" ... while the amount of marine surface data available at NMC has increased tremendously, receipt of ship and drifting buoy data remain low..."

Quarterly ship track summaries of all VOS observations are tabulated and distributed to the Marine Observing Program of the Observing Systems Branch. Each reporting VOS receives a Mercator map depicting it's track north of the equator during the past three months and the total number of reports received at NMC.

Through the monitoring effort it is apparent that while the amount of surface marine data available at NMC has increased tremendously, the receipt of ship and drifting buoy data remain low and needs improvement.

In an attempt to increase the number of surface observations received at NMC, monthly and quarterly surface marine tabulations are delivered to the Marine Observing Program of the Observing Systems Branch and the National Ocean Services for distribution to voluntary ship operators. It is hoped that this will encourage timely and complete transmission of ship observations to NMC.



The Value of an Observation

"Weather observational techniques have changed greatly during the past few years. In just a little more than two decades we have seen air reconnaissance evolve from a short "PIREP" (pilot report) to a very detailed and complete surface and upper air report obtained by sophisticated automatic instrumentation. Powerful radars with ranges of 250 miles form a complete net around our mainland. Other radars are scattered throughout the islands and aboard ships, and automatic weather buoys will one day dot our oceans. During the single month of February 1964, there were over 7,000 usable pictures taken by our satellites, TIROS VII and VIII. Being aware of all the new technology, perhaps you have felt, at times, that your surface observation is passe or not really as important as it was a few years back. If you have, you underestimate the value of your cooperation. The very first thing that a huricane forecaster does, upon recognizing or suspecting a developing storm or a deteriorating weather situation, is to ask for special reports from the ships in the area. The new techniques will never supplant the ships observation; in many cases, we need them even more to better interpret what we have obtained from the other sources."

This exerpt from Arnold Sugg's, *Your Weather Observation*, appeared in the M W L in 1964. It remains apropos today. But that's not the end of the observation. It goes to the National Climatic Data Center and as these excerpts from Dick Whiting's *Marine Meteorological Observations* (Mariners Weather Log, July 1969) indicate, the observation lives eternally.

" Private groups, as well as government agencies, use large amounts of summarized marine meteorological data. In addition to the gale tables and Ocean Station Vessel summaries published in the Mariners Weather Log, material is furnished to : U.S. Navy —series of *Marine Climate Atlases*, U.S. Naval Oceanographic Office— *Sailing Directions* and *Pilot Charts*. Defense Intelligence Agency — global summaries, Environmental Science Services Administration — hurricane studies, storm data, summaries for representative ocean areas, the series of *Climatological and Oceanographic Atlases for Mariners* in cooperation with the U.S. Naval Oceanographic Office, and the *Coast Pilots* for the U.S. Coast and Geodetic Survey.

" The NWRC also provides data-processing facilities to a number of university, institute, and government users of marine environmental data. Among these are the Woods Hole Oceanographic Institution, Scripps Institution of Oceanography, the National Hurricane Center, the University of Hawaii, and the National Oceanographic Data Center.

"While many of today's advanced programs in the field of marine meteorology are oriented toward improved forecasts, the basic weather records obtained from these programs can provide an extremely useful data base for special investigations. The Global Atmospheric Research Program (GARP), the Global Horizontal Sounding Technique (GHOST), the World Weather Watch (WWW), the Barbados Oceanographic and Meteorological Experiment (BOMEX), and the additional meteorological satellites will produce an enormous volume of raw observational data.

"Even though special meteorological programs are increasing in prominence and extensive, large-scale observations are being made over designated areas, the cooperative merchant marine observer remains as the backbone of Marine Weather observations. We would like to thank the men on the cooperating ships who participate in this routine, sometimes monotonous, but very important effort. One key observation, from a remote portion of the ocean today, may save a life tomorrow."

Whale Oil and Wicks

–by Elinor DeWire
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Key Biscayne, with its graceful palms and tawny beaches, is one of Florida's most idyllic retreats, but it wasn't always so accessible. Back in 1825, when the Cape Florida Lighthouse was first illuminated, the only way to reach Key Biscayne was by boat, and the only residents of the isle were the lighthouse keepers.

Florida's Dade County was virtual wilderness in those days. The tiny settlement of Miami would easily have fit inside a modern supermarket. There were no close neighbors for the lightkeepers, and the ships passing the light were only dots on the horizon. Theirs was a hard, Florida frontier existence— battling insects, heat, and isolation— but there were pleasures not afforded at other lighthouses.

Keepers' wives filled their tureens with green turtle soup and fried up big batches of conch meat and onions. They made salads from cabbage palms, like the Indians did, and wove ornate fans from palmetto switches. Just outside the door was the tepid, opaline water of the upper keys, a shallow underwater park that turned many a lightkeeper's wife into a mermaid.

Cape Florida Lighthouse, as Key Biscayne's beacon was officially called, was entrusted with the important task of marking the northern fringe of the Florida Reef. The Gulf Stream hugs the shore closely here, and the strait is riddled with dragon's teeth coral capable of ripping open the strongest ship's hull.

There are many shallow spots, too, and a host of wave–battered wrecks to justify the nickname, "Graveyard of the Atlantic." Several other stretches of Atlantic Coast lay claim to this name, among them the Outer Banks, Cape Cod, and Canada's Sable Island, but the Florida Reef boldly displays its skeletons as proof. One can barely cruise a square mile of this area without seeing the bleached ribs of some manmade leviathan laying on the shallow bottom or projecting out of the water like some dead sea monster.

' Neither pirates, nor storms, nor mooncussers could compare with the horror that befell Cape Florida's lightkeepers in 1836 however.'

As if shoals and sandbars are not enough, the Cape Florida lightkeeper's job was made even more difficult by the notorious hurricanes that sweep the Southeast from June to November and the cutthroat pirates who preyed upon ships struggling through the Florida Strait. For a time, lightkeepers had to deal with "mooncussing," an unscrupulous practice of exhibiting false lights to lure ships to their doom. Its practitioners were called "mooncussers" because they detested bright, moonlit nights when vessels could see the perils around them.

Neither pirates, nor storms, nor mooncussers could compare with the horror that befell Cape Florida's lightkeepers in 1836 however. Indian trouble had begun in South Florida and, as the Seminoles' anger escalated, they set their sights on the lighthouse. One hot, July afternoon they paddled their canoes out to Key Biscayne and attacked the station.

Assistant Keeper John Thompson and Henry, his black helper, grabbed guns and took refuge in the lighthouse. They managed to hold off the marauding Seminoles until nightfall when a shower of bullets pierced the oil tanks and doused everything, including the men, with whale oil. A fiery arrow shot into the tower set it ablaze.

The two men fled to the lantern as the wooden stairway burned behind them. The deck grew hotter; its paint curled and burned away. Trapped like two fish in a frying pan, the men clamored to the edge of the gallery, but were greeted with a shower of bullets. Their dilemma was formidable— remain on the lantern deck and be burned alive or step to the cooler rim and be shot.

In agony, Henry attempted to jump,

National Archives

The Florida Lighthouse, circa 1890. The 1987 U.S. Coast Pilot reads: "Cape Florida Light 95 feet above the water is shown from a brown conical tower on Cape Florida, the southern point of Key Biscayne. Many tall apartment hotels on the easterly side of Key Biscayne are also prominent."

but was shot and fell dead beside Thompson. Thinking to end his own suffering as well, Thompson picked up a keg of gunpowder and hurled it into the inferno below him. The explosion shook the tower from top to bottom, but instead of killing Thompson, it caused the flaming timbers to drop to the floor of the lighthouse and smolder.

Naked and severely burned, Thompson lapsed into a painful sleep. Thinking both men were dead, the Indians departed, but not before they looted and burned the keeper's house and stole his boat.

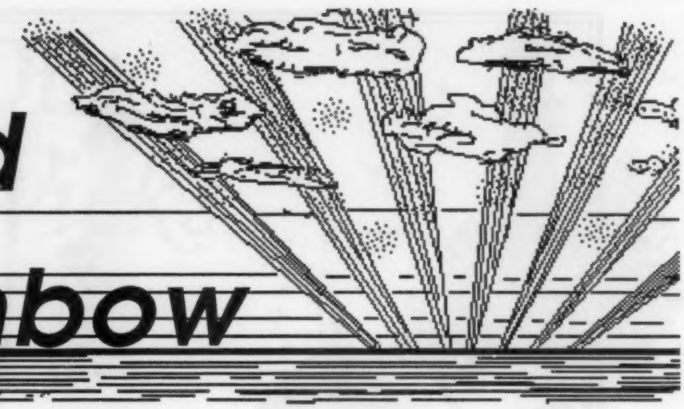
Thompson awoke the next morning to a grisly scene. The pristine splendor that had been Cape Florida Light Station now looked like a war zone. Even the trees had been decapitated. Adding to Thompson's misery were the notorious Key Biscayne mosquitoes which were feasting on his raw flesh.

Henry's body had begun to reek in the heat too, and it was with great remorse that Thompson pushed his faithful friend off the gallery and heard his body hit the parched ground below with a lifeless thud. As noon approached, and the scorching July sun blazed down on him, Thompson passed out. A short time later, voices jarred him to consciousness, and he was able to raise himself enough to see a schooner laying just offshore. It was the ***USS Motto***, a Navy ship that had seen the glow of flames at Cape Florida the night before and come to investigate. Imagine the crew's surprise when they discovered Thompson on top of the lighthouse, his clothing and hair burned off and several toes and fingers missing from bullets. Amazingly, Thompson survived his ordeal. The ***Motto's*** men rescued him from the tower and took him to a military hospital. His burns healed, but he was too crippled both physically and emotionally to return to duty. Likely his experience at Cape Florida cured him of any further ambition to tend a lighthouse.

The Cape Florida Light was repaired and relit in 1846, after Indian troubles subsided in South Florida. A decade later, the government increased its height to 90-feet and gave it a sparkling new French lens, but the jewel suffered considerable damage in the Civil War when the Rebels put out the beacon.

With the construction of Fowey Rocks Lighthouse in 1878, just a few miles offshore of Key Biscayne, the old Cape Florida Light was discontinued. It stood dark for 100 years before being ceremoniously relit by the Florida Department of Parks. It now shines over the Bill Baggs State Recreational Area, and the entire compound has been restored for public enjoyment. As the oldest structure in South Florida, it proudly stands as a monument to Florida's early pioneers.

beyond the rainbow



William R. Corliss
P.O. Box 107
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"Unusual Natural Phenomena at Sea"

The earth's atmosphere absorbs sunlight and streams of subatomic particles spewed out by the sun. This influx of solar energy fuels many of our terrestrial luminous phenomena. Various chemical and electrical processes convert solar energy into auroras, lightning, St. Elmo's Fire, and a host of curious and beautiful phenomena.

The next year-and-a-half may provide mariners with the opportunity of witnessing of these phenomena as well as some rare anomalies as the sun reaches a peak of eruptions in its 11-year cycle.

One such event has already occurred. Jets of energy bursting out of the sun on May 4, 1988 caused a major magnetic storm to ripple over the Earth on the 5th and 6th, which resulted in radio and telephone disruptions and a bright blue-and-white aurora borealis. This aurora was seen at least as far south as the NOAA offices in Boulder, CO.

The Earth's magnetic field loops far into space. "The field is stable, but when you have a disturbance on the sun the effect is like the buffeting of a boat on the sea— when you drop a rock in the water you can see the boat bounce," said Joe Hirman of NOAA's Space Environment Services Center in Boulder. Minuscule particles in the upper atmosphere, trapped in the magnetic field of the Earth as iron filings are around a magnet, are hit by the wave from the sun and accelerated down into the upper atmosphere where they strike other atoms. The collisions create a charged, glowing gas, like that in a neon light — the aurora.

The sun's disturbances— flares, sunspots and filaments— increase in frequency and intensity on a cycle of about 11 years. Hirman said Earth can expect as many as two dozen major magnetic storms over the next 18 months. A few will reach severe intensity, where the Northern Lights are brilliant, multicolored and can be seen as far south as Cuba.

These powerful magnetic storms may be responsible for anomalies known as glowing night skies as well as geographically displaced auroras. Southward auroras are very rare in the latitudes of the United States. On March 30, 1984 an aurora was first seen in Lyons, NY at 7:40 p.m. It then consisted of flickering, irregular patches which filled the entire heavens from the zenith down to the southern horizon. There was nothing whatever to be seen in the usual location of auroras toward the north. Southward, in Pennsylvania, the entire sky was more or less covered with flickering patches and masses of light. Still farther south, the aurora was seen toward the north at Charleston, SC , rising about 25° above the northern horizon.

Glowing night skies are strongly enhanced general illumination of all or most of the night sky. These rare milky-white enhancements may be strong enough to permit the reading of a newspaper outside at midnight. They are most likely caused by bursts of solar wind or micrometeoroids. One report in Florida in 1886 reads: "I awoke a little before 3:00 a.m. and noticed that it was very light, and as there was no moon, got up and went out on the deck, and to my surprise saw everything illuminated with a pale greenish light so intense that we could read by it .... The atmosphere was hazy and we could not make out the stars, and the light seemed to be general and from no particular direction."

Another anomaly, known as transient sky brightening, is less easily explained. These sudden, bright

flashes of light covering all or most of the sky, last from one to several seconds. On May 4, 1931 in the North Atlantic, sea and sky were suddenly quite brilliantly lit for about 3 seconds with a flickering purplish light, which did not appear to emanate from any particular point. The Marine Observer reported that, in the North Pacific on December 5, 1956 there was a report of a harsh, brilliant flash, bluish white in appearance, covering the whole of the night sky and lasting for about 1 1/2 seconds. The possibility of a meteor was ruled out as thick cloud cover would not have permitted it to be visible, and the character and intensity of the flash did not conform to lightning or other electrical phenomena. The forecastle head was plainly visible from the bridge and the horizon clearly defined. In the South Atlantic on the 28th of December, 1980 on a moonless night the entire ship and immediate surrounding area were illuminated by what can be best described as a great camera flash. The flash was bluish white and a small bolt of lightning appeared to be centered just above the vessel's samson posts. No noise was heard and the flash only lasted a second. The sky was clear at the time and stars of all magnitudes were clearly visible.

An example of an Aurora with an unusual shape was spotted in Finalnd on November 16, 1871 (right). It was observed at the presbytery of Enare. This aurora took on the form of a glowing red band, curved as shown in the sketch. The two extremities bordered on yellow and green.

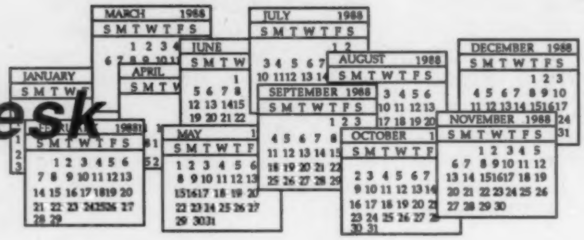
There are no available explanations for this type of anomaly and they are usually one-of-a-kind, however this does not rule out the possibility of their existence. Most complex, natural phenomena are characterized by rare "wild points" and observations that do not fit the mold.

An auroral "loop"

University of Alaska at Fairbanks

The repertoire of "normal" auroral displays is remarkable, ranging from an unimpressive, dull-greenish glow just tinting the northern horizon, to a kaleidoscope of flickering red, yellow and bluish flames and arches that fill the heavens.

the editor's desk



Why the Derbyshire jig-saw may never fit

by Nick Thompson
("reprinted by kind permission of Lloyd's List")

The chances of Commissioner of Wreck, Gerald Darling, ever reaching a firm conclusion on what happened to the ***Derbyshire*** are probably no greater now than when the formal inquiry opened nearly six months ago.

A bold statement perhaps, but the concluding remarks made by the lawyers taking part in the proceedings suggest Mr. Darling and his official team of three assessors have little other choice.

With no eye witness accounts and no physical evidence from the shop itself, the Wreck Commissioner is clearly unable to reach any definite findings about what happened to the 169,044 tonnes deadweight combination carrier as she lay hove-to in a Pacific typhoon.

Instead he has to balance the long list of probabilities and improbabilities, possibilities and impossibilities which have been put forward by the legal teams and technical experts during the 46 days that the inquiry sat in public.

As one barrister pointed out, even Sir Arthur Conan Doyle's dictum that "when you eliminate the impossible, whatever remains, however improbable must be the truth" cannot be employed in this case.

"Mr. Steel's remark about a "thorough inquiry" was not just a throw away line."

The dictum can only apply when all relevant facts are known so that all possible explanations, except a single extremely improbable one, can properly be eliminated.

All of which leaves Mr. Darling with the difficult task of ruling on what was the least improbable cause of the casualty rather than the most likely.

David Steel, QC, counsel for the Transport Secretary actually felt it necessary to reassure the Wreck Commissioner that there would be no "intellectual cowardice" in concluding the true cause of the casualty could not be identified.

He added: "I am conscious that no court of inquiry would be enthusiastic to reach no conclusion on the probable cause of loss after a thorough investigation, but that is a result which may be forced upon the court, dispiriting though it may be, because it would be equally, if not more, unsafe to try to force a conclusion out of the material the court has before it."

Mr. Steel's remark about a "thorough" inquiry was not just a throw away line. Scientists and engineers worldwide were commissioned to prepare reports and dozens of witnesses, including those who built the ***Derbyshire*** and her sisters in the early 1970s, were traced.

But in his own concluding remarks, even Mr. Steel was forced to admit that his own expert advisers only had a "gut feeling" that the least improbable cause for the mysterious disappearance would be hatch cover failure.

The Department of Transport has effectively ruled out such matters as explosion, engine failure, steering gear failure, broaching-to, dry shift of cargo and external hull damage as causes of the casualty on the grounds that they are the most improbable explanations.

Instead, it has concentrated its thoughts on the three main

theories introduced during the inquiry by the ship's owners, her builders, her classification society and the relatives of the 44 people who lost their lives.

"On Sept. 9 she reported she was hove-to in 30-ft high waves... She was never heard from again."

All three theories—hatch cover failure, structural collapse and cargo liquefaction—hinge on the appalling weather which the four-year-old ship encountered in her final hours.

Loaded with iron ore, the Derbyshire had set off from Sept Isles in Canada in July 1980 and had proceeded by Cape Horn with a crew of 42 and two officers' wives on board.

On Sept 9 she reported she was hove-to in 30-ft high waves and that her arrival in Japan would be delayed by a few days. She was never heard from again.

Lawyers for the relatives pursued the most controversial theory throughout the inquiry — that design faults and construction errors allegedly found on the Derbyshire's surviving sisterships after 1980 indicated that she may have suffered a massive structural collapse around her No. 65 bulkhead.

Geoffrey Brice, QC, told the inquiry on its second day that "massive failure" was the only plausible cause of the casualty.

By the end, he still insisted that design and construction were not satisfactory but he had to agree that why, how and where water got into the ship was not known.

He added: "What one can say is that the incursion of water into the ship was due to failure of some part of parts of her structure, albeit we recognize that there are difficulties in way of the court identifying which part or parts of the structure were involved."

Swan Hunter, which built the ***Derbyshire*** at its now-closed Haverton Hill yard on Teesside, has submitted that Mr. Darling can find that there may have been local cracking in the hatchside girder near frame 65, but the probability is that it did not cause or contribute to the casualty.

Lloyd's Register, which gave the ***Derbyshire*** the highest possible classification, described the frame 65 theory for the loss of the ship as "incredible."

"Hull girder failure at all is a very improbable explanation indeed," said Adrian Hamilton, QC. "If it did occur it would not have been at frame 65, it would have been admidships."

The classification society has put forward the idea that the lower layers of the iron ore in two partly-filled holds may have been liquefied by the ship's motion and then suddenly shifted.

Extra weight on one side of the ship would then have induced cargo-shift in the remaining five holds being used and would have led to capsize.

Swan Hunter and the ship's owners, Bibby Tankers, both favour the hatch cover theory. Reports from another ship in the same area later suggested waves of up to 100 ft were being experienced when the storm was at its height.

In the failing light, even the most diligent of watch officers would not have been able to see the damage being caused to the steel covers over the forward holds.

The ship may have had time to transmit an SOS message but if she did, none was ever received. Her disappearance remains as great a mystery today as ever.

Collision in Fog

A. U.S. Navy ship's collision with a commercial fishing vessel on April 21, 1987 off the coast of Virginia resulted from operational errors by the Navy vessel's two senior officers, the National Transportation Safety Board (NTSB) has concluded. It said the failure of the fishermen to make their presence known to the rapidly approaching ship contributed to the accident.

There were no fatalities nor injuries. Damage was estimated at $112,000. The vessels had working radar, radios and fog horns. The accident occurred about 85 miles off Virginia Beach with visibility reduced by fog to 1/2 mile or less. Involved was the 415-foot ***USS Richard L. Page***, a guided-missile frigate, and the 66-foot wooden-hulled ***Chickadee***. The latter had been disabled and was in tow by another fishing vessel, the ***Mariner***.

The ***USS Page*** on a full-power trial was accelerating just before it struck the starboard bow of the ***Chickadee***. Six feet of the fishing vessel's bow was severed and it sank. Three ***Chickadee*** crewmembers were rescued from the ocean by the ***Mariner*** before severe hypothermia occurred.

"The National Transportation Safety Board determines that the probable cause of the collision between the ***Page*** and the ***Chickadee*** was the failure, in part the result of fatigue and stress, of the officer-of-the- deck (OOD) of the ***Page*** to treat a reported radar contact as a vessel and to inform the commanding office (CO) of the contact, and the lack of command oversight by the CO and his decision to operate his vessel at high speed in restricted visibility," said the NTSB in its report. It continued:

"Contributing to the collision was the failure of the watchstanders on the ***Mariner*** and the ***Chickadee*** to make known their presence to the rapidly approaching ***Page*** by VHF/FM radiotelephone or by sounding their whistle or both, the failure of the CO and the OOD of the ***Page*** to broadcast a security call on VHF/FM radio-telephone before beginning a full power trial, and the failure of all vessels to sound fog signals."

(There is nothing better than first–hand weather experience. The next best thing is to listen to someone who has been through it. Kevin Shaw was kind enough to share his experience on the Chesapeake Bay. These are the kinds of articles we like to receive.—ed)

Chesapeake Bay Cold Front

by Kevin Shaw
National Ocean Service, NOAA

On April 15, 1988, Fred Bode and I went sailing with , Paul Spence, on his 34 foot boat out on the Chesapeake Bay. Our sail over to Tilghman Island was uneventful under sunny skies, cool temperatures and light breezes of 5 to 10 knots. We listened to the weather radio on the way over. Although there was mention of a cold frontal passage during the evening hours, nothing alarming appeared to be in the forecast. After a late lunch we made some minor adjustments on the sails and left to sail back at approximately 6:30 p.m. EDT.

I turned the radio on (Captain's orders) as soon as we were underway. A strong cold front was approaching the area from the west, and would blow through the area between 7 and 8 p.m. EDT. Winds were strong and gusty at the frontal passage; 35 knots or greater. The day was not particularly warm nor humid; so I reasoned that summer–like, convective activity would not be the problem that evening. Later on, when we heard the radar summary, my theory was borne out—no thunderstorms in sight of the radar at Patuxent. There was mention of possibly Small–Craft Warnings being posted on the Bay but that had evidently not been decided as yet.

At approximately 7:30 P.M., when we were about in the middle of the Bay, (the Chesapeake Bay is about 12 miles wide at this point) we had southwest to west winds at about 8 to 12 knots and seas were running 1 foot. We could see some dark clouds to the west but they were too far away to be able to determine what affect they would have on our weather. But we certainly kept an eye on them. We had been motor sailing. That is, we had the head sail up but the motor on at 3000 RPM to maintain a forward speed of 7 knots or so—about as fast as we could go under those conditions. Our general bearing of 285° was a west northwest heading that was putting us right into the wind, the roughest way to travel in heavy seas.

The first band of significant clouds came through about 7:50 p.m. when we were about 3 miles from shore. The winds increased 16 to 20 knots and whitecaps could be seen on some of the waves, which by now were building in the 2 to 3 foot range. Still nothing really unusual and we had the situation well-in-hand. In fact, we still had the head sail up. About 10 minutes later all hell broke loose. The second line of clouds came upon us very rapidly and day became night. There was no rain or thunder, but the sky looked just as menacing. I could not believe how quickly conditions worsened. Winds increased to a steady 35 to 40 knots with gusts of more than 50 knots. Seas built to 6 to 7 feet in no time. The boat

heaved—we managed to get the head sail down in a real hurry at the outset of the blow—and then, as they say in maritime folklore, we battened down the hatches. Paul was in full control of the situation but was still a bit nervous. Fred stayed below. I wanted to stay out on deck to help out and to experience the storm first hand. In the process, we were rapidly soaked. This soaking was from the waves crashing into and over the boat and onto us. I really could not tell honestly if any rain fell at all!

I could not believe, as we ever so slowly approached shore, that the waves seemed to be getting bigger. There just wasn't that much of a "fetch" for the waves to build to these great heights. I felt I was out in the mid-Atlantic in a near hurricane. Water temperatures were in the upper 40s (°F) so getting soaked wasn't exactly the greatest feeling in the world. Then, getting heaved about so, we lost sight of Herring Bay Entrance Light "1". If you head into Herrington Harbour with this light too far to your right, you might get yourself in trouble with shallow water and wrecks in the way. The aid was to our right! Paul had me frequently looking at the depth gauge and reporting the reading to him. We finally sighted Herrington Harbour Entrance Light "1", which was our marker for safety. We had to change course in order to head for this aid, and the new course gave us our roughest waves yet. During one particular rough one I thought for a moment we were going over. We managed to survive that and several other rough ones. We headed into the Herrington Harbour Channel but not until we got fully between the protective jetties did the water finally subside. Things were still blowing hard and heavy; we had a lot of trouble even getting into the slip. We must have made a half a dozen passes before we got the correct orientation to slide into the slip. I did hear an unconfirmed report that when the front hit the Virginia Beach, VA area that wind gusts of 60 knots were recorded.

marine observation program

—by Martin S. Baron
National Weather Service
Silver Spring, MD 20910

The Port Meteorological Officer's Get-together

The PMO's Meeting this June 15-17 in Silver Spring, MD was very successful. Matters relating to the Voluntary Observing Ship (VOS) Program were reviewed and there were many suggestions for improvements. It was also an opportunity to get to know one another better on a personal level. Many thanks to Dick DeAngelis, MWL editor, for taking the group photo.

The Cast of Characters

1. Jim Mullick, PMO San Francisco, 2. Pete Connors, PMO Miami 3. Dale Eubanks, Chief Obs. Br., Ft Worth, 4. Larry Cain, PMO Jacksonville 5. Ray Brown, PMO Norfolk 6. George Smith, PMO Cleveland 7. Jim Nelson, PMO Galveston 8. Vince Zegowitz, Marine Obs. Program Leader 9. Marty Baron VOS Program Manager 10. Andy Brewington, Marine Obs. Specialist, Anchorage 11. George Klein, PMO Newark 12. Pete Celone, PMO Honolulu 13. Bob Melrose, PMO Panama 14. Dave Bakeman, PMO Seattle 15. Bob Webster, PMO Los Angeles 16. Bob Collins, PMO Chicago. Missing: Jim Downing, PMO New Orleans and Bob Baskerville, PMO New York.

New National Weather Service Director Thanks Ship's Officers

Dr. Elbert W. Friday, Jr. has been selected as the new Assistant Administrator for Weather Services effective March 27, 1988. He had been serving as Deputy Assistant Administrator since September, 1981. Dr. Friday succeeded Dr. Richard Hallgren who left government service to assume the position of Executive Director of the American Meteorological Society. In a letter to all observers aboard ship, Dr. Friday reiterates the importance of weather observations from ships at sea:

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE
Silver Spring, Md. 20910

JUL 25 1988

Dear Master, Mates, and Radio Officers:

Greetings! As the new Assistant Administrator for Weather Services for the United States Department of Commerce's National Weather Service (NWS), I extend my deepest gratitude to ships' officers for their dedication, time, and support as weather observers in the Voluntary Observing Ship Program.

Weather forecasts for the vast marine areas of the globe would not be possible without your cooperation. Ships' weather observations are used during all stages of the weather forecasting process -- to evaluate your local weather conditions, to locate and determine the strength of fronts and other weather systems, and to prepare the weather charts used by meteorologists worldwide. Your observations also help with weather predictions for heavily populated coastal land areas because marine weather systems often move inland. The NWS is grateful for every observation that you provide.

I cannot overstate the value of your continuing participation as weather observers. Thanks for your effort -- I wish you the best of success in your maritime endeavors.

Sincerely,

Elbert W. Friday, Jr.
Assistant Administrator
for Weather Services

New PMO for Honolulu

Peter J. Celone has been selected as the new PMO at Honolulu, Hawaii, replacing Aki Kimura who retired in March. Peter was born and raised in Bristol, Rhode Island, attended public schools there, and graduated from the University of Rhode Island in 1978 with a degree in Marine Sciences. In 1979 he was commissioned into the NOAA Corps. His first assignment in 1980 was aboard the NOAA Ship ***Researcher***, where he served as Meteorology Officer. From 1982 to 1984 he worked for the National Marine Fisheries Service in Narragansett, Rhode Island, and participated in the NWS/

NMFS Ship of Opportunity Program. Peter was then assigned as Navigator to the NOSS Ship ***Townsend Cromwell*** which operates in the Central and South Pacific Ocean. In 1987 he was transferred to the National Weather Service Pacific Region Headquarters as Ocean Services Coordinator. In addition to his PMO responsibilities, he is also active in the Mariners Reports (MAREP) Program. Peter and his wife Christine have one son, and live in Aiea, Hawaii.

The International Scope of the Voluntary Observing Ship Program

Meteorology depends on the cooperation of all nations to provide observed data. This is because atmospheric circulations and their associated weather systems are global in size. International collaboration is accomplished largely through the World Meteorological Organization (WMO). WMO committee conferences establish guidelines for data collection, set code policy (covering observation times, type of data to be included, code symbols), and supervise co-operative efforts between nations in weather prediction and meteorological research.

The WMO Voluntary Observing Ships' (VOS) scheme is part of the Global Observing System of the WMO sponsored World Weather Watch. WMO publication No. 47 lists 7286 weather reporting vessels worldwide, in the VOS programs of 49 different countries. These ships are supervised by some 88 full time and many other part time port meteorological officers (PMO's) worldwide. The WMO lists 5 main purposes of PMO visits to ships:

1. To maintain personal contact with master, deck, and radio officers.

2. To check meteorological instruments. All instruments must be checked for proper exposure. Calibrate barometers and barographs to read sea-level pressure at least twice each year, and during each visit. Psychrometers must be checked for proper functioning, and the wicks changed, if needed. Attention must be paid to sea water thermometers, and anemometers aboard.

3. To provide instructions regarding the taking of observations, keeping of meteorological logbooks, and transmission of weather reports.

4. To provide the necessary forms.

5. To provide weather information.

Upon request of the master of any ship, regardless of its nation of registry, PMO's will come aboard, check meteorological instruments, and provide advice or assistance in meteorological matters. The WMO recommends that PMO's prioritize their ship visits by first visiting ships which have not yet been recruited as weather observers. This is an effort to expand the amount of incoming data. In this case, the PMO tries to stimulate interest in maritime meteorology among the officers and to encourage them to take observations. Next, the WMO expects PMO's to visit vessels on their own VOS program registers. Finally, the PMO is requested to make courtesy visits to foreign supervised ships (vessels taking observations for countries other than his own)

Corrections

There were several missing words in the marine observations program article dealing with the use of upper air charts, spring, 1988, pages 24-25. These are in bold type below. In the second paragraph of the discussion, a missing word from the text may have confused the point—that the size, location, and speed of upper air troughs and ridges provides the key to predicting the weather in the middle latitudes. 500 millibar troughs help locate fronts, low pressure systems, likely precipitation areas, and colder air masses (behind the cold front), as shown by the diagram top of page 25 in the spring issue. 500 mb ridges delineate areas of high pressure—generally fair, dry, and warmer conditions. The weather associated with both troughs and ridges is more pronounced with higher amplitude flow patterns.

At the bottom of page 25, first column, it was pointed out that waves of shorter length move more rapidly than longer waves. There was a missing sentence segment—a short wave trough overtaking and moving into a long wave trough **amplifies the long wave (this often leads to storm development or cyclogenesis** east of the long wave trough. This is similar to what happens when two sea or swell and sea wave troughs phase together—producing one larger amplitude, more energetic wave.

In the last paragraph of the discussion, the second to last sentence was chopped off. It should have read **"Mathematical relationships relate** these phenomena (amplitude, length, and speed of waves, vorticity and thermal advection etc.) and form **the basis of the** numerical weather prediction models.

PMO report

—by Bob Collins
National Weather Service
Chicago, IL

Certificate of Appreciation to the Philip R. Clarke

In appreciation for the help in the Great Lakes Marine Observing Program, PMO Bob Collins sent the Philip R. Clarke the certificate proudly displayed by second mate Robert Zeitler and Captain Francis Altman. The vessel was coming in to Fraser Shipyards in Superior for its winter lay-up when this photo, which appeared in **The Evening Telegram** of Superior, WI, was snapped. (Ship photo by Howard Mackey.)

tips to the radio officer

—*by Jullie L. Houston*
National Weather Service
Silver Spring, Md.

Meteorological Surface Observations

Ships are reminded to use the correct format for Meteorological Surface Observations. Meteorological Surface Obs should begin with the **Ship's call sign.**

INMARSAT Format Example

WLXX 29003 99131 70808 41998 60909 10250 2021/
40110 52003
71611 85264 22234 00261 31100 40803 .....

Coastal Radio Stations Example

WLXX 2900399131 7080841998 6090910250 2021/
40110 5200371611
8526422234 0026120201 3110040803

INMARSAT Reports Procedure

INMARSAT equipped ships may transmit weather messages using the following procedures after the message is composed off-line:

1. Select U.S. Coast Earth Station Identification Cole 01.

2. Select routine priority.

3. Select duplex telex channel.

4. Initiate the call.
   Upon receipt of GA+ (Go Ahead).

5. Select dial code for meteorological reports, 41, followed by the end of selection signal, +.
   41+ (or 00 23 6715250+)

6. Upon receipt of our answerback, **NWS OBS MHTS**, transmit the ships call sign and the weather message only. Do not send any other preamble.

Selected Worldwide Marine Weather Broadcast

The publication "Selected Worldwide Marine Weather Broadcast" is being reformatted and updated. Please send any schedule changes to the following address:

National Weather Service
International Telecommunications
Section W/0S)151 ROOM 419
8060 13th Street
Silver Spring, MD 20910

Information concerning Coast Earth Station ID codes and Telex and Telephone Country Codes can be found in the INMARSAT Users Guide. The Users Guide is available a the address listed below:

COMSAT Maritime Services
950 L'Enfant Plaza, S.W.
Washington, DC 20024

ATTN: James Jansco

Bathy/Tesac Observations

Ships are reminded to use the correct format for Bathythermal/Tesac Observations. Bathy/Tesac should start with **JJXX** and end with the **Call Sign.**

EXAMPLE: **JJXX** 20106 0312/ 74519 05528 88888
00098 26097 28098 29094 33069
36044 37026 38014 39009 41004 46503 48505 59508
84512 990
36512 37512 38512 39355 46355 00000 **VCTB**

hurricane alley

Herbie the Cyclone

Herbie developed in the South Indian Ocean northwest of Australia in May of 1988. On the 19th, with his center near 16°N, 97°E, he was generating maximum 35-knot winds with gusts to 45 kn. The tropical storm was moving toward the southeast at about 20 knots. By the 20th it was turning extratropical as it approached the west coast of Australia. However before he was through Herbie caused some problems to shipping. The ***Korean Star*** (see cover), dragged anchor and grounded in the vicinity of Cape Cuvier at about 2100 (UTC) on the 20th. The crew of 19 Koreans abandoned the ship via a "flying fox" rigged by the State Emergency Services and were put up at Carnarvon township. The "flying fox" was a pulley arrangement between the vessel and nearby cliffs. Herbie also caused the 40-ton trawler ***Northerly*** and two other trawlers to break common mooring lines and slam into the rocky beach at Denham. The ***Northerly*** was left on the shoreline and was battered by the others. The town of Denham also suffered extensive damage.

Hurricane Risks

"It is now more clear than ever that hundreds of lives could be lost if a major hurricane sweeps across a large population center this year," according to Robert Sheets director of the National Hurricane Center. Some 43 million people inhabit the 175 coastal counties in 18 states from Maine to Texas. Coastal communities and barrier islands are particularly vulnerable due to lengthy evacuation times and often a reliance on bridges and causeways. Apathy is probably the greatest peril with any rare event. While people associate the hurricane danger with high winds, the storm surge is the greatest killer. This is a dome of lashing water that sweeps ahead of the hurricane eye. Nine out of ten hurricane deaths result from drowning.

NOAA will once again activate a hurricane hotline to provide timely information direct from the National Hurricane Center. It will be in operation whenever a named tropical storm or hurricane has developed. The hotline can be reached by dialing **900-410-NOAA**. Non AT&T subscribers can reach the service by first dialing 1-0 288-900. Typical recordings identify coastal areas under hurricane watch or warning storm position, wind speeds, anticipated path and tidal effects.

Tropical Cyclone Anne

Satya Kishore
Fiji Meteorological Service

Tropical cyclone Anne was the first cyclone of the 1987-88 season in the Southwest Pacific. She also ranks as one of the most intense cyclones in recent years.

From the middle of December the South Pacific Convergence Zone began intensifying as westerlies appeared near the equator. Two depressions formed near Tuvalu towards the end of December. Although the low-level conditions were ideal for the development of a tropical cyclone at this stage, the surrounding upper-level circulation was unfavorable and the first depression dissipated while still in the low-latitudes. Early in January the low-level circulation around Tuvalu became disturbed once again and by the 5th of January a shallow depression developed just to the east of the group. About this time a depression appeared along the same longitudes east of the Marshall Islands in the northern hemisphere. Between this "twin" arrangement the equatorial westerlies gained further momentum and both depressions started deepening.

By the 7th the southern hemisphere depression had developed to gale intensity when it moved over Tuvalu. In spite of a somewhat strong upper-level easterly flow the system continued to deepen. Clouds associated with the depression began to organize and a feeder band appeared in the northern sector. The system was named Anne and upgraded to storm intensity.

Anne continued southwestwards and her speed increased to 10 knots. She began to intensify rapidly on the 9th. The cyclone was upgraded to a hurricane, with maximum average

winds estimated at about 65 knots, as she passed within 30 miles northwest of Anuta around 0000 on the 10th.

Anne continued to deepen. A few hours after 1200 she passed directly over the Torres Islands and came within 40 miles of Ureparapara in the nearby Banks Islands. Fortunately for the rest of Vanuatu she continued moving toward the southwest at about 15 knots.

The cyclone peaked around 0000 on the 11th as maximum average winds, near its center, were estimated at 100 knots. After 1200 it suddenly started curving to the south and headed towards New Caledonia. On the 12th the cyclone changed its course toward the southeast. It began losing intensity as it came under the influence of upper-level shearing. Around this time tropical cyclone Agi formed near Louisdale Archipelago of Papua New Guinea about 650 miles northwest of Anne's position. Agi gradually gained storm intensity as it rapidly moved towards the southeast, apparently drawn toward the relatively deeper Anne. By the 14th she was within 300 miles of Anne.

By 1200 on the 12th Anne, about 30 miles to the north of New Caledonia, was weakening rapidly as she approached land. Nevertheless, the northeastern areas of New Caledonia were exposed to destructive winds before the cyclone made landfall, about 60 miles north northwest of Noumea, around 1800 on the 12th. The following day Anne moved away to the south.

The cyclone caused severe damage on the Torres Islands; almost the entire population lost their houses as well as their cash crops. Damage to the nearby Ureparapara Island and the northwestern parts of Espiritu Santo was equally severe. Flooding, landslides and storm surges augmented the damage to property and crops. Reports of 4–to 5–meter tidal waves washing away several houses on the west coast of Ureparapara have been received.

No official reports of damage were received from New Caledonia but newspaper reports indicate extensive damage to the main island of New Caledonia, especially on the eastern coast, which was exposed to a prolonged period of storm force winds. Torrential rain caused widespread flooding. Although not officially reported, significant storm surge is likely to have affected the eastern coast. Two cyclone related deaths were reported.

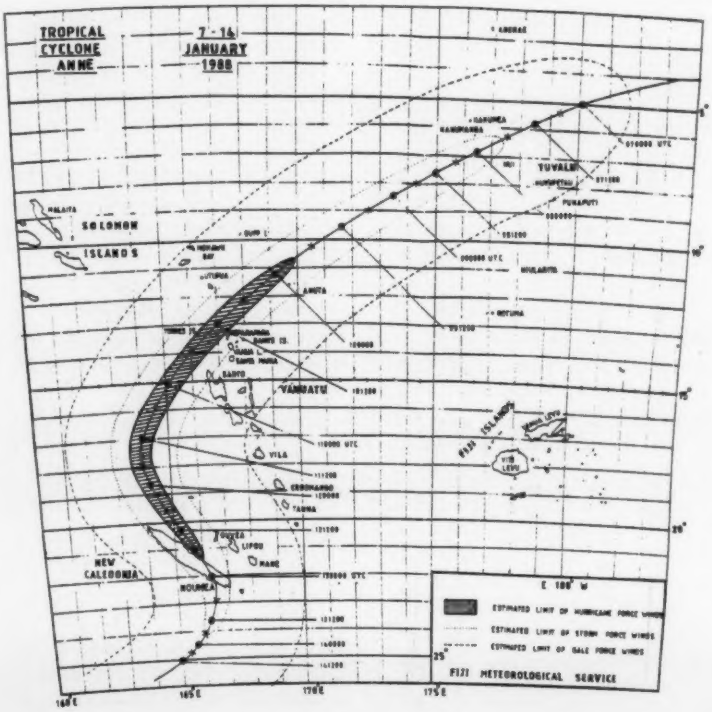
Anne moved across the Santa Cruz Islands with average winds estimated at 80 knots near her center. Fortunately the center did not pass directly over any island. The nearby small islands were also fortunate enough to escape the destructive hurricane force winds. The cyclone was also moving at about 15 knots at this time and, therefore, the gale and storm force winds, which affected the islands, were not prolonged.

Reports of extensive damage to houses and crops were received from the islands of Anuta, Duff, Utupua and Reef Islands. Lata, another small island in Santa Cruz reported minor damage. Reports of damage from other islands are not available.There were no reports of any casualties. Anne passed across central Tuvalu while it was still in its early stages of development. Damage to houses and cash crops like bananas and coconuts was classified as minor.

Tropical Cyclone Bola

Rajendra Prasad
Fiji Meteorological Service

Tropical Cyclone Bola caused severe damage in Vanuatu and affected parts of Fiji. He then proceeded southwards as an extratropical depression causing severe flooding in New Zealand. The cyclone evolved from a depression in the South Pacific Convergence Zone between Fiji and Rotuma. Upon acquiring tropical cyclone characteristics on the 26th of February, 1988 the system moved

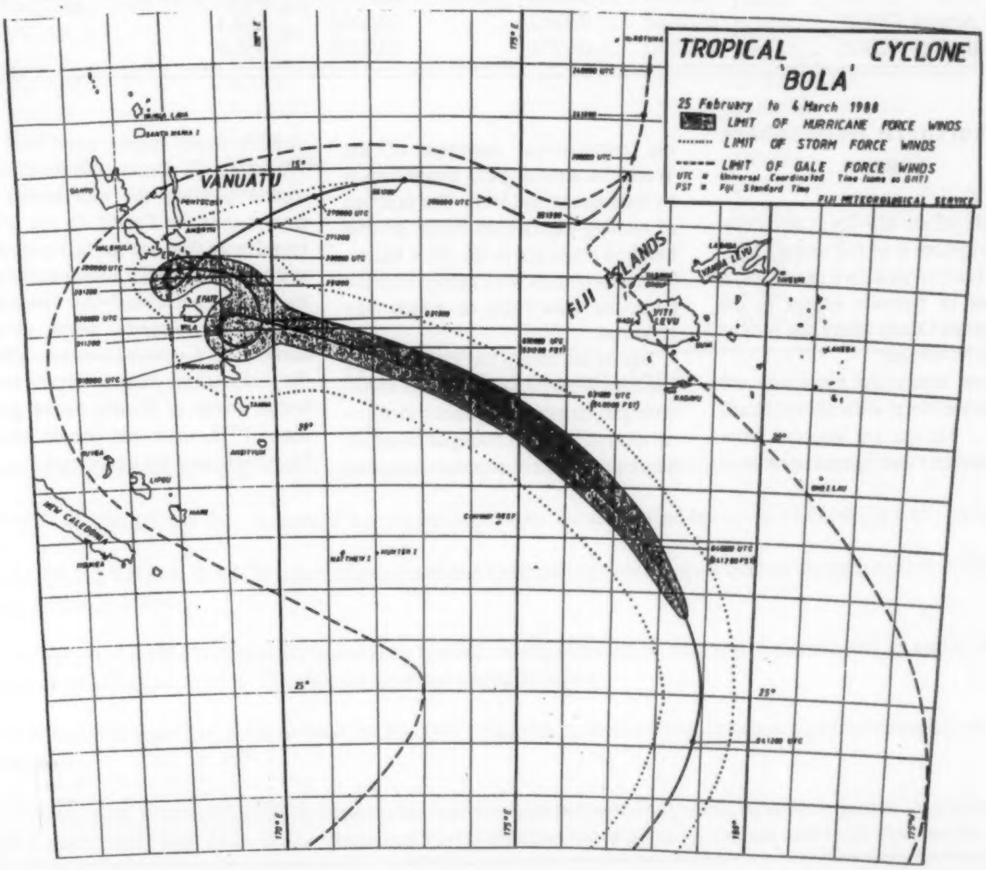


westward. It made two clockwise loops in the vicinity of Vanuatu between the 28th of February and 2d of March before heading in an east southeast direction toward Fiji. It passed about 140 miles southwest of Kadavu in the early hours of the 4th.

Bola is estimated to have attained peak intensity around 0600 on the 1st of March as maximum sustained winds were estimated at 90 knots with gusts up to 130 knots close to his center. He maintained this intensity for about 24 hours. The system lost all characteristics of a tropical cyclone near 27°S and 178°E around 1800 on the 4th, but maintained storm intensity and an abnormally wide area of gales for several days afterwards.

Bola was the second cyclone of this season, and the fifth major cyclone since 1985, to have hit the Republic of Vanuatu. Its impact seems to have been most on Shepherds and Epi Islands, Paama, the southeastern parts of Ambrym and Malekula and the surrounding smaller islands, where at least 3000 households and more than 15,000 people were severely affected. There was widespread damage to local housing and some of the more permanent buildings such as schools and local government offices were completely destroyed. Heavy rain caused landslides and some roads and bridges were washed away. The cost of reconstruction was estimated at roughly $500 thousand U.S. in a report received from Vanuatu. Rain also affected many local gardens while sea spray and storm surge had an adverse effect on crops. No loss of life was reported from the Republic. A couple of vessels went aground (but were later refloated). One barge, carrying building materials from Fiji for a new wharf project at Malekula, sank.

Bola passed 180 miles southwest of Nadi and 140 miles southwest of Kadavu early on the 4th. Winds in most of the Group appear to have peaked between 0330 and 0900 FST. Nadi Airport recorded a maximum average wind of 44 knots with a gust of 67 knots at 0435 FST on the 4th, highest of all reporting stations. The effect of Bola on the country was minimal. There were no reports of any structural damage, and the only damage reported was that to crops, especially sugarcane and pawpaws. Even this was classified as very minor. However, an open punt with six fishermen on board on their way from Kadavu to Vatulele after a fishing trip was reported missing on the 3d of March, when Bola was about 330 miles away from Fiji. Repeated air searches for these men failed to find them and they are presumed to have drowned.



Tropical Cyclone Bola						
Station	Max. avg. wind dir/speed (kn)	date/time (UTC)	Max gust dir/speed (kn)	date/time (UTC)	Min. pressure (mb)	date/time (UTC)
Vanuatu						
Pekoa	260/20	29/1700	210/35	29/1900		
Lamap	260/50	29/1500	260/60	29/1500	979.5	29/1500
Bauerfield	210/29	02/1500	230/46	01/1200	977.8	02/1500
Port Vila	200/39	02/0808	210/60	02/0622	977.3	02/1550
Tanna	070/28	29/2300	130/39	02/2000	986.0	02/1400
Aneityum	130/20	30/0200	140/40	02/0900	991.0	03/0500
Fiji						
Udu Point	330/28	03/2100	330/33	03/2100	100.4	
Nabouwalu	300/30	03/1800	300/43	03/2300	990.0	
Viwa	350/40	03/1500	340/50	03/1500	993.8	
Vanuabalavu	310/20	04/0600	310/30	04/0600	999.0	
Lakeba	350/16	04/0000	350/25	04/0000	999.3	
Matuku	010/23	03/1800	010/28	04/0300	996.4	
Vunisea	030/38	03/2100	030/60	03/2100	992.8	
Ono-i-Lau	330/30	03/1500	330/45	03/1500	994.5	
Nadi Airport	030/44	03/1630	030/67	03/1635	994.4	
Laucala Bay	020/15	03/1530	020/38	03/1530	993.0	

The Northern Hemisphere Season

Tropical cyclone activity in the northern hemisphere is in full swing. September is the most active month for a hurricane or typhoon except in the North Indian Ocean where one is most likely in November.

Tropical storms and hurricanes are named in the North Atlantic and North Pacific. Names are selected from library sources and agreed upon during international meetings of the World Meterorological Organization by the nations involved. The practice of naming hurrricanes began several hundred years ago in the West Indies. Many hurricanes were named after the particular saint's day on which they occurred.

Before the end of the 19th century, Clement Wragge, an Australian meteorologist, began giving names to tropical storms. At the National Weather Service, the use of womens names to identify these storms goes back to World War II. During this time, forecasters plotting the movements of storms over the Pacific Ocean often found more than one storm in progress at the same time. To avoid confusion, forecasters, particularly Air Force and Navy meteorologists, began giving each storm a woman's name. Often they selected the names of their sweethearts, wives, or favorite pin-up girls. Since 1978, male and female names have been used for hurricanes.

Tropical Cyclone Names, 1988

North Atlantic	Eastern North Pacific	Central North Pacific	(pronounced)	Western North Pacific
ALBERTO	ALETTA	ULEKI	oo-LEH-kee	ROY
BERYL	BUD	WILA	Vee-lah	SUSAN
CHRIS	CARLOTTA	AKA	AH-kah	THAD
DEBBY	DANIEL	EKEKA	eh-KEH-kah	VANESSA
ERNESTO	EMILIA	HALI	HAH-Lee	WARREN
FLORENCE	FABIO			AGNES
GILBERT	GILMA			BILL
HELENE	HECTOR			CLARA
ISAAC	IVA			DOYLE
JOAN	JOHN			ELSIE
KEITH	KRISTY			FABIAN
LESLIE	LANE			GAY
MICHAEL	MIRIAM			HAL
NADINE	NORMAN			IRMA
OSCAR	OLIVIA			JEFF
PATTY	PAUL			KIT
RAFAEL	ROSA			LEE
SANDY	SERGIO			MAMIE
TONY	TARA			NELSON
VALERIE	VICENTE			ODESSA
WILLIAM	WILLA			PAT
				RUBY
				SKIP
				TESS
				VAL
				WINONA

Hurricane Terminology

TROPICAL DISTURBANCE - A moving area of thunderstorms in the tropics that maintains its identity for 24 hours or more.

TROPICAL DEPRESSION - A tropical low pressure area with sustained wind speeds of 33 knots (38 mph) or less.

A TROPICAL STORM WATCH is an announcement that a tropical storm or tropical storm conditions pose a threat to coastal areas within 36 hours.

A TROPICAL STORM WARINING is issued for specific coastal areas where tropical storm conditions, including sustained winds of 34 to 63 knots (39 to 73 mph), are expected within 24 hours.

A HURRICANE WATCH IS AN ANNOUNCEMENT for specific areas that a hurricane poses a threat to coastal areas within 36 hours.

A HURRICANE WARNING will be issued if hurricane conditions (sustained winds equal to or greater than 64 knots [74 mph], dangerously high water and/or dangerous waves) are expected in a specific coastal area in 24 hours or less.

MARINE WEATHER REVIEW

January—The Icelandic Low, which looms as a climatological aid to winter mariners in the North Atlantic, loomed larger this month (fig 1). The result—negative pressure anomalies with a center of -15 mb just north of Ireland. To make matters worse the Azores-Bermuda High was potent, creating a tight pressure gradient across the shipping lanes between the U.S. and Europe. The 700-mb upper level steering currents were oriented from the west southwest to east northeast, which helped concentrate storms over northeastern waters.

On This Date—January 20, 1978—A paralyzing northeaster produced 21 in of snow at Boston, MA and wind gusts to 60 kn along the Connecticut coast.

Extratropical Cyclones—The month opened and closed with blockbusters in the northeastern North Atlantic. Across the ocean several storms were responsible for a snowy month along the U. S. East Coast. In the Great Lakes region a winter storm, which had been responsible for the coastal disaster in southern California (see Pacific Log), brought heavy snow to Wisconsin and upper Michigan as well as blizzard conditions on the 20th. Whiteouts were reported at Marquette along with 22 in of snow and drifts 5 to 6 ft deep.

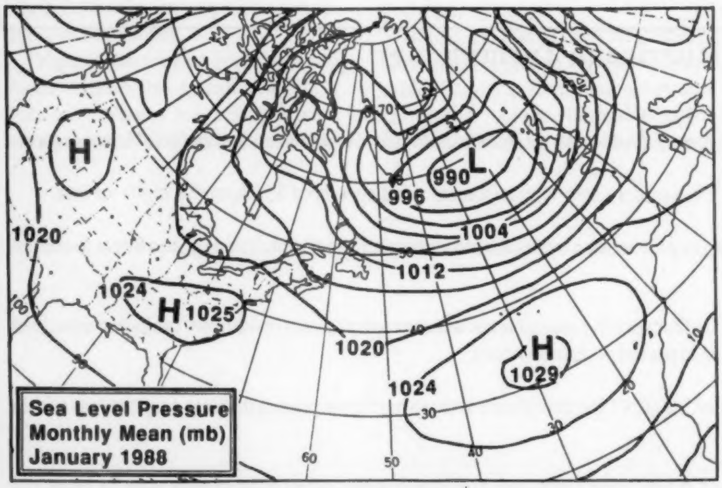


Figure 1.—The Icelandic Low dominates the climate pattern, an ominous picture for mariners.

❶ To continue the saga from last month, this system had merged with another on New Years Day. This invigorated storm now turned toward the east, moving along the 60th parallel south of Iceland. By 1200 on the 2d the central pressure was down to 952 mb (fig 2), and the storm was dominating the weather from Greenland to central Europe. Nobody was to close to the center, it seems, but a vessel (H046) near 62°N,14°W reported a 964-mb pressure in 44-kn northeasterlies. Most of the reports to the south and southeast of the center had winds ranging from 40 to 55 kn in swells of 13 to 20 ft. Conditions were rough in the western approaches to the English Channel as well as in the North Sea. The ***Champs Elysees*** (51°N, 2°E) encountered 48-kn southwesterlies in 13- ft seas late on the 2d. The system weakened as it moved into Norway late the following day.

The Weather Logs, the cyclone tracks, buoy, gale and wave tables and mean pressure patterns provide a definitive report on the primary storms that affect the North Atalntic and North Pacific Oceans. The Monster of the Month is a title given to an extratropical storm that have been hazardous to shipping. All storms are dangerous.Unles stated, winds are sustained and time is UTC. The number next to the summary corresponds to the appropriate number on the track chart.

North Atlantic Weather Log

January, February and March, 1988

❷ **Monster of the Month**—On the 2d an atmospheric wave began to develop along a stationary front, which hung over the Gulf of Mexico. The following day another storm came to life near Lake Winnepeg in Canada. These two systems were destined to meet over the Gulf of St. Lawrence on the 5th. The Gulf of Mexico Low made its way along the East Coast of the U. S. while the Canadian Low came by way of Ontario and Quebec. Neither was much to talk about until after they joined forces. By 1200 on the 6th the combined center was just east of Goose Bay with a pressure estimated at 950 mb—a drop of 28 mb in 24 hr. This was quickly noticed over the North Atlantic shipping lanes where gale and storm force winds were being encountered. The potency of this system was testified to by the ***Farland***, which reported, near 47°N, 57°W at 1200 on the 6th, 65-kn west southwesterlies in 20-ft seas and swells estimated at 46 ft. The ***SEDCO 710***, one of our most consistent observers, clocked 55-kn winds in 23-ft seas, some 550 mi southeast of the center. At 1800 storm force winds were being reported by the VRKA, ***Sealand Express, Vishva Parijat*** and the ***Farland***. Seas at this time were running from 14 to 30 ft. The ***Farland*** was encountering 33-ft swells. The storm continued to rage as it moved east northeastward. Central pressure was estimated at 944 mb at 0000 on the 7th. Winds ranged from 40 to 60 kn throughout the day. However, on the 8th winds dropped significantly and it looked as though the system was falling apart. Then on the 9th, just south of Iceland, another system joined the monster to give it a second life. Central pressure dropped to 948 mb as the storm headed northeastward. Vessels in the Norwegian Sea began to send in reports of storm force winds with seas running up to 20 ft. The potent system finally made its way into the Barents Sea by the 11th.

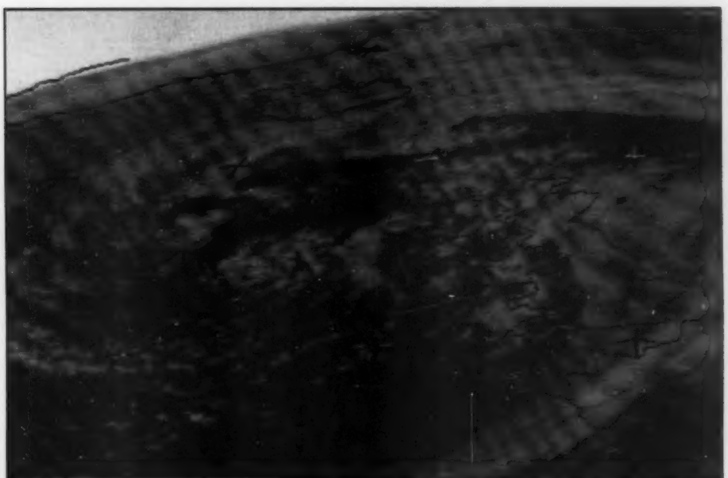


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Figure 2.—The 952-mb storm at 1130 on the 2d is centered south of Iceland.

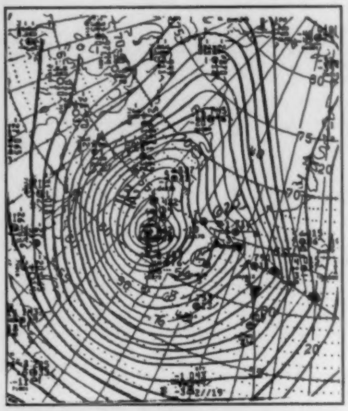

Figure 3.—A dramatic weather chart at 0000 on the 16th.

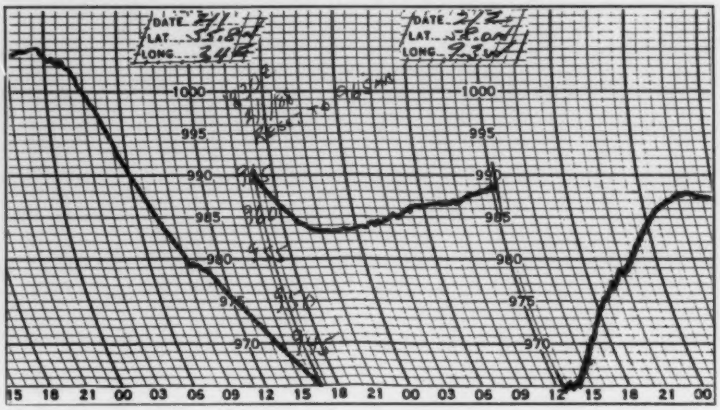

*Figure 4.—The barograph chart from the **Sealand Producer**.*

❸ If this system had developed over the shipping lanes it would have been the monster of the month if not the year. However, it intensified in the Labrador Sea and moved northward along the west coast of Greenland before fading near Thule on the 17th. It had come to life on the 10th over northern Montana. Two days later it moved through the Great Lakes as a 994-mb Low. By the 14th it was into the Labrador Sea sporting a 980-mb pressure—still nothing to write home about. At 0000 on the 15th, the maps showed the 974-mb storm just off the Labrador coast with a small 986-mb center off Kap Farvel and a 979-mb Low near Godthaab. Six hr later there was one 948-mb center just south of Kap Farvel. The southern part of the circulation stretched to south of 40°N. The old reliable ***Sedco 710*** (47°N, 49°W) reported 55-kn westerlies in 23-ft seas. This region was particularly vulnerable, because a large 1037-mb High was centered near Long Island creating a tremendous pressure gradient over the Grand Banks and southern Labrador Sea. Storm force winds were common. The ***Atlantic Compass*** (52°N, 38°W) at 1200, was caught in 60-kn southwesterlies and was estimating seas at 43 ft with a slope of about 1/16. Fortunately the storm split and moved away from the major lanes. The more potent storm headed into the Davis St. while a weaker version headed toward the Denmark St. The Davis St storm deepened to an estimated 932 mb by 0000 on the 16th (fig 3). Frederikshab, near the center, recorded a 936.2-mb pressure and Godthaab to the north clocked winds of 55 kn and a 948.2– mb pressure. The gradient was intense between Greenland and Labrador. The system continued northward but began to slowly weaken as it hugged the coast.

❹ Another Gulf of Mexico storm created problems over the northern shipping lanes this month. This one was first detected on the 24th off southern Texas. As it moved up the East coast of the U.S. it dumped from 4 to 5 in of snow in New England and the mid Atlantic states. By the 27th it was moving through the Gulf of St. Lawrence and continuing to deepen. At 1200 the central pressure had dipped to 966 mb. ***Sedco 710*** reported in with 52-kn winds in 20-ft seas, while the VSBC (47°N, 48°W) hit 44-kn southwesterlies in 20-ft seas. By 1200 on the 28th the 958-mb system was causing havoc over a good portion of the northern North Atlantic, with the assistance of a large 1037-mb High to the south. The ***Albright Pioneer***, near 51°N, 28°N, was nailed by a 52-kn blow from the west while battling 30-ft swells. **OSV C** a little farther to the west was also encountering 52-winds and battling 39-foot seas with a slope of about 1/30. They had battled conditions nearly all day and into the 29th. To add to the misery of this last week another potent system was developing to the southwest along the cold front of this storm, which was beginning to divide and weaken on the 29th.

❺ By the 30th it was apparent that this system was taking control. Moving northeastward central pressure fell from 994 mb at 1200 on the 30th to 966 mb by 1200 on the 31st. At 0600 on the 31st the VSBT ran into 51–kn winds while the ***Donny*** reported a 60-kn southerly near 48°N, 26°W; these increased to 63 kn by 1200 when winds in the 45 to 55 kn range were common. Some vessels were encountering seas up to 33 ft. The storm moved across northern Scotland on the lst with a 960-mb pressure center. Gale and storm force winds continued to be reported particularly in the North Sea where the weather played havoc with shipping (see Casualty Section). The Falmouth coast guards reported a gust of 82 kn. The ***Sealand Producer*** after leaving Bremerhaven for Port Everglades ran into the storm and had to reset the barograph chart (fig 4). Also see February.

Tropical Cyclones—There were no tropical cyclones this month.

Casualties— The last storm of the month was responsible for a number of incidents. On the 2d of February the ***Churchill*** (46°N, 7°W) lost 10 containers overboard. The ***Amazzone*** encountered bad weather off Penmarc'h on the night of the 30th; she had one tank seriously damaged and lost some 3 thousand tons of heavy fuel. The 2,723 - ton ***Rolandia***, with a crew of 12, sent out a distress signal on the 29th; by the time the U.K. reefer vessel ***Geestcape*** arrived a few hours later the vessel had turned over and there was no sign of the crew. Three liferafts were found—all empty. The ***Sovereign Explorer*** a semi-submersible drilling platform was drifting 40 mi off Land's End after a cable linking it to a tug broke in high seas. Thirty-six people were aboard.

Early in the month the ***Mitera Sotiria*** ran aground on rocks in a heavy storm. One man lost his life in an attempt to rescue the crew. The crew of ten was eventually taken off in a helicopter.

February—Its amazing how much you can glean from a climatological chart (fig 5). This month a double center appears on either side of Iceland representing the Icelandic Low, which is not unusual. Both however are displaced from their normal positions, one usually near the Denmark St and the other off northern Norway, and also deeper than normal. This lead to a -10 mb anomaly centered off southern Norway and a -8 mb anomaly centered in the Davis St. And this is where the action was this month, much to the regret of shipping, particularly around Great Britain, including the North Sea. This was aided additionally by the 700-mb steering currents, which curved sharply, cyclonically northward in the Davis Strait region, and northeastward to eastward from off the U. S. to Europe.

On this date—February 8, 1987—Northerly winds of 40 to 60 kn combined with high tides to produce 12- to 18- ft waves on Lake Michigan, resulting in the worse flooding and erosion on record along the Chicago shoreline (fig 6).

Extratropical Cyclones—One of January's most potent storms raised havoc early in February as its 960-mb center moved across northern Scotland on the 1st. The storm had caused five deaths in France and five others were missing at sea. Winds of more than 85 kn and torrential rains lashed the west of England and Wales. Caernarfon Airport in north Wales clocked a 97–kn gust and a workman was killed by a falling tree in Wales. In Helston, north Cornwall, some homes were under 4 ft of water. (See January summary for more details).

A Low, which had formed over Yugoslavia along a front from the previously mentioned system on the last day of January, created problems in the western Mediterranean area. Sandstorms closed airports in Egypt, while high waves and strong winds kept the ports of Alexandria and Suez closed for several days. On the 1st some 50 vessels were trapped in the Suez Canal. The 50-kn winds were responsible for six deaths and 13 injuries in scattered incidents. It was reported in Jordan that the worst storm in half a century blanket parts of the country with up to 20 in of snow while others were flooded with record rainfall (see Casualties).

❶ While England was in the throes of the late January–early February storm, another system was intensifying off the southeast tip of Greenland on the 1st. The 977-mb Low swept southeastward and then on the 3d turned toward the northeast to give the British Isles its second bashing within the first few days of the month. Early on the 3d ahead of the associated cold front, in the Bay of Biscay, several vessels reported winds in the 50-to 58-kn range; namely the ***Chaumont*** and the ***Beursagracht***. In the North Sea winds were running about 40 to 50 kn. Seas of 10 to 15 ft were being reported in the North Sea and to the west of the British Isles as the system moved across Ireland and into Scotland on the 4th. Winds remained close to or at storm force. At 0600 on the 4th the ***Chaumont*** reported, near 49°N, 5°W, 52-kn southwesterlies. At 1200 the ***Ritchardas Boukaouskas*** encountered 50-kn southerlies west of Denmark. The storm generated storm force winds through the 5th as it moved into the Norwegian Sea. At 0600 on the 5th the ELBU was hit by a 64-kn westerly near 54°N, 4°E while

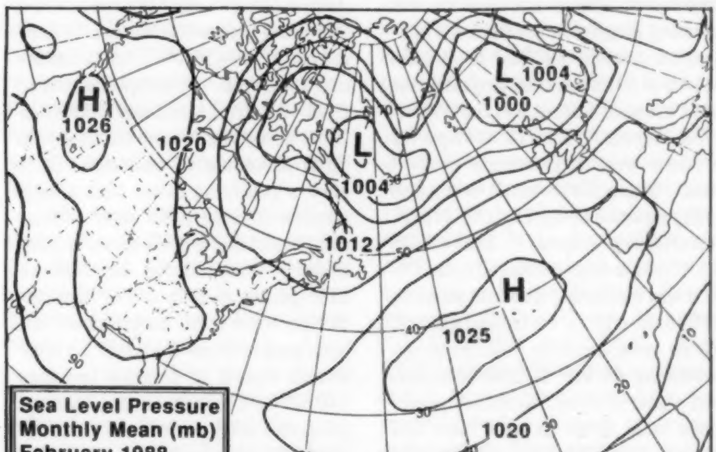

Figure 5.—The double-centered Icelandic Low means trouble over the northern shipping lanes.

Wide World

Figure 6.—Workmen try to reinforce a sea wall as waves pound Chicago's Lake Michigan shoreline on the 8th of February, 1987. Residences and miles of public parks suffered $7 million damage from the combination of the storm and abnormal lake levels.

the ***Iolair*** confirmed this with a 58-kn report of her own; both reported swells in the 25 ft range.

❷ **Monster of the Month**—As if the waters around the British Isles hadn't suffered enough, an even more potent storm was brewing on the 7th just north of Bermuda. By 1200 on the 8th it had crossed the 50th parallel and its center was at 980 mb. **OSV C**, about 150 mi west northwest of the center, was reporting 41-kn northwesterlies in 21-ft seas. To the southeast the ***S. Petri*** ran into the cold front's 60-kn west southwesterlies in 13-ft swells. By 1800 the central pressure was estimated at 965 mb. At 0000 on the 9th ***OSV L*** (57.6°N, 20.7°W) reported a 965.5-mb pressure about 120 mi from the center. This helped establish a 960-mb center. The storm now turned westward. In 6 hr pressure was down to 950 mb and the storm was creating rough weather from the Norwegian Sea to the Bay of Biscay. Winds of 50 kn were blowing along the west coast of Ireland and the ***Friedrich Engels*** (52°N, 18°W) reported a 60-kn west northwesterly in 39-ft seas. Storm force winds were also being reported by the ***Daishu Maru***, ***Nuernberg Express*** and VSBR. By 1200 the Irish Meteorological Office was estimating a central pressure of 945 mb (fig 7). In Ireland gusts of 70 kn were common with some approaching 85 kn. Belmullet station had a gust of 93 kn. Trees and power lines were down in cold rains and snow. Limerick City was flooded when strong winds blowing up the Shannon estuary caused the water to rise, while high seas battered the western coasts. Five deaths were attributed to the storm. At 1200 more than 40 reports of gale and storm (50 kn) force wind were radioed in. The ***Isle of Arran*** (55.8°N, 5.0°W) measured a 953.9-mb pressure while the ***Alexei Khlobystov*** (55.1°N, 7.5°W) measure 956.1 mb. Windspeeds ranged from 40 to 65 kn and seas from 10 to 25 ft. Some swells were running 40 to 50 ft according to estimates. It is always gratifying to see such a large number of reports in such adverse conditions; that's dedication. Above freezing temperatures kept things from getting entirely out of hand, although wind chill factors were uncomfortable to say the least. At 1800 sixteen reports of pressure less than 970 mb were received and in four the pressure was below 960 mb. Three 60-kn wind reports came in as did several reports of 30-ft plus seas. The storm continued to rage into that good night of the 9th, as it made its way into the North Sea. From 1800 to 0000 on the

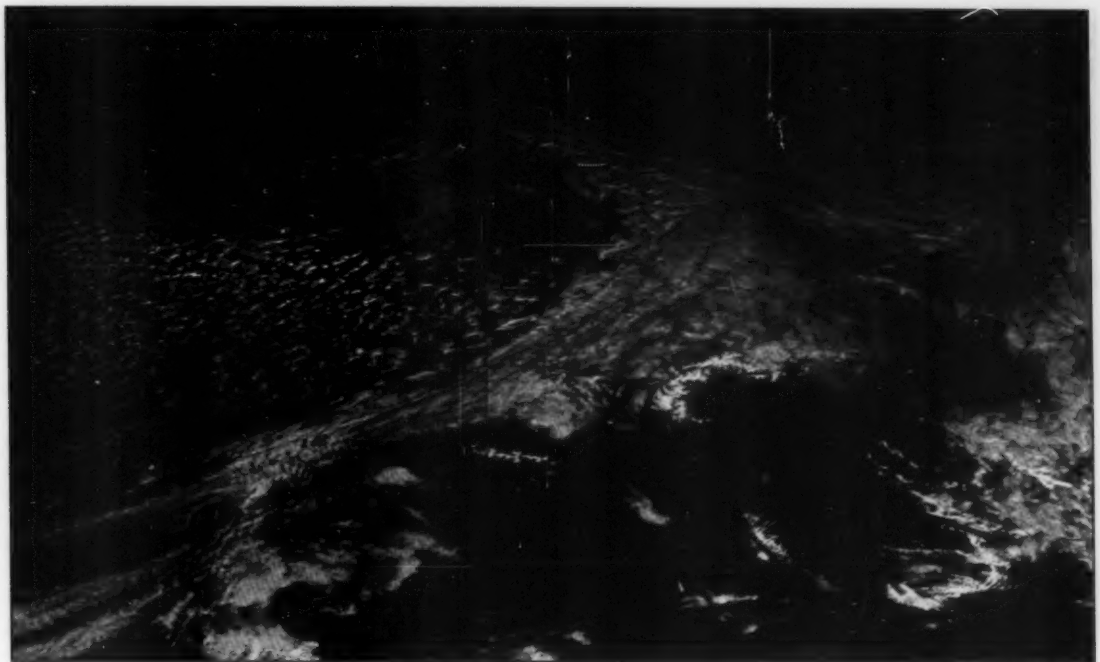
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Figure 7.—The Monster of the Month near its peak at 1130 on the 9th. The 945-mb storm was dominating the weather from the Norwegian Sea to the Bay of Biscay.

10th the central pressure rose from 948 mb to 957 mb and some relief was in sight. However it was a terrible night to be sailing, or even out, from the Norwegian Sea to the Bay of Biscay. Many ships and platforms painted an accurate picture of this viscious storm, which finally ran aground in southern Norway on the 10th. By the 11th these seas gained a measure of relief they hadn't seen for nearly 2 weeks, even though several smaller storms moved through the area during the next few days.

The death toll was estimated at seven, five of them occurred in the Irish Republic. On the mainland gales caused blizzards and in north Derbyshire heavy snow drifted and blocked some major roads.

❻ For a change of pace the western Atlantic was the scene of the next major storm. On the 12th the breeding grounds off Georgia spawned a Low, while another had already come to life over western Tennessee the day before. These storms were due to merge on the 13th over Maine. On the 12th at 0600 a vessel off the southern Virginia coast reported a 44-kn southeasterly. Six hr later both the ***Humber Arm*** and the CGDW encountered 40-kn winds east of the center. The two systems were spreading gales and snow from New England to the eastern Great Lakes on the 13th. Brattleboro reported 22 in of snow while 18 in fell at Rochester. The system merged on the 13th as central pressure dropped to 978 mb, and the system headed northeastward across the Gulf of St. Lawrence. The CGSB hit 50-kn winds in the mouth of the St. Lawrence River at 1200. At 1800 storm force winds were encountered by the ***Wilfred Templeman, Irving Ours Polaire,*** CGBK, CGBN and CGSB. The CGBN reported 58-kn east southeasterlies. Most of the vessels were in the mouth of the St. Lawrence, very close to the center. Their pressures ranged from 979 to 987 mb. This and their wind directions indicated another center had formed to the west. This center also moved northeastward and joined the original in the Labrador Sea on the 15th, resulting in a 970-mb storm, whose influence extended into the shipping lanes. At 1200 on the 15th the Normacsun (41°N,51°W) hit 45-kn westerlies and 18- ft swells more than 1000 mi south of the center. The system turned northward and headed through the Davis St. and into Baffin Bay on the 17th.

❼ On the 22d a large High built in over the mid North Atlantic south of Iceland. It remained quasi stationary for the remainder of the month. In fact it built into a tremendous system with a central pressure that rose to 1054 mb, a pressure rarely seen at these latitudes. This super High was instrumental in influencing the movement of the last storm of the month and its pressure gradient helped create a very strong flow across Great Britain and the North Sea.

On the 26th the Low developed just north of Iceland. With the High providing a block the system moved eastward and intensified slowly. At 1200

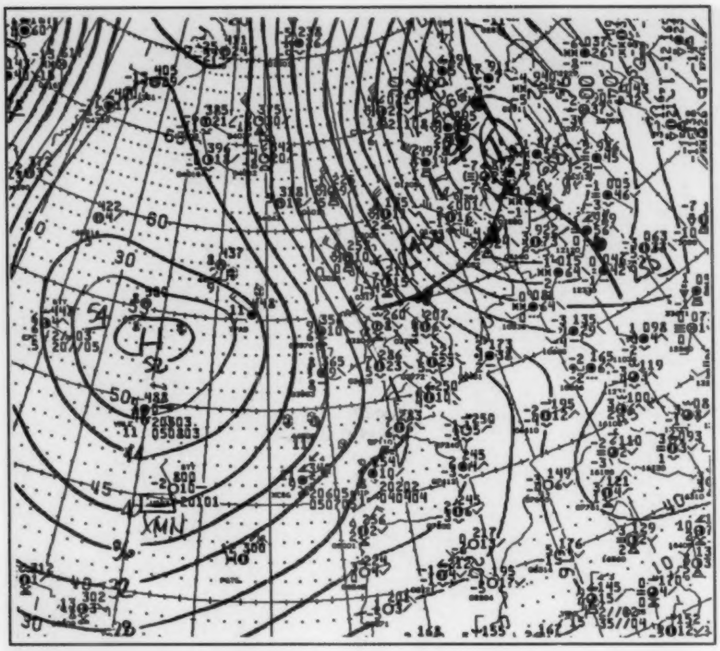

Figure 8.—The 1054-mb High creates a tight pressure gradient with the rather moderate Low over Norway at 0600 on the 28th.

on the 27th its central pressure was still at 993 mb near 70°N. By 1800 it had turned toward the southeast. A vessel near 61°N, 3°W ran into 54-kn westerlies and the rampage had begun. At 0000 on the 28th the center was over Trondheim, Norway and storm force winds were common in the North and Norwegian Seas (fig 8). The ***Seagair***, near 62°N, 1°E, ran into 60-kn northwesterlies while battling 30-ft seas with a slope of about 1/17. At 0600 the winds were ranging from 40 to 55 kn in the North Sea and seas were running 15 to 30 ft. Central pressure at 1200 was estimated at 978 mb but the gradient was so tight that many vessels were reporting pressures in the 1000 to 1008 mb range. In fact the GJMP (57°N, 7°W) reported a 1028-mb pressure with 45-kn north northwesterlies. The gradient across the North Sea was creating problems for ships and rigs. There were four reports of 60-kn plus winds at 1200 including, the ***Iolair***, which encountered 65-kn northwesterlies in 26-ft seas with a slope of 1/10. By 1800 its winds were up to 70 kn with seas of 33 ft near 58°N, 1°E. This was confirmed by the ***Valur*** nearby which reported 68-kn northerlies. The North Sea was boiling. At this time the strongest winds seemed to be north of 54°N. By 0000 on the 29th the storm center had moved to southern Sweden. Five reports of 60-kn winds came in and seas were running up to 28 ft. Conditions seemed to be slowly improving. However, at 0600 the ***Maersk Dispatcher*** (58°N, 2°E) hit 65-kn northerlies and a couple of rigs reported winds in the 60 to 65 kn range. Several estimates of 36-ft seas were also received. Gales were even being encountered off Cabo Finisterre, Spain and off northern Norway. The fact that the High was very persistent and the Low was moving slowly southward kept the gradient tight through the end of the month. Conditions finally began to improve on the 1st of March.

Casualties—A freak surge of water may have caused a gas platform accident 35 mi east of the Humber estuary, on the 10th, in which two men lost their lives. Seas were 10 ft with 25-kn winds at the time, conditions which were nothing unusual. However it was understood that a surge of water lifted the vessel entangling it with a crane hook dragging the crane overboard as the surge retreated suddenly and lowered the vessel. On the 9th the Trawling fish factory ***Cerna*** was blown aground in Lough Swilly on the North Coast of Ireland. The same storm damaged the rudder of the tanker ***Hellesport Courage*** as she fought to keep from being blown onto the coast of County Donegal. Assisted by tug ***Raysterer*** she finally anchored safely in Brodick Bay. The ro-ro container ***Rover*** sustained heavy weather damage on the 9th enroute to Brixhain from Nordenham. The ***Purity*** reported contact with the ***Almutanbbi*** on the 14th during heavy weather in the Mediterranean. The ***Tag VI*** encountered heavy weather off Southwest Pass, LA on the 5th.

On the 29th at 0920 the platform ***Santa Fe Rig 135*** with a crew of 77 was adrift in the North Sea after the towline parted in hurricane force winds. Helicopters winched 35 men from the rig while another 19 were airlifted from a production platform in its path. At 1457 the tow was reconnected. Two of the seventeen seamen were injured on the 28th when the ro-ro vessel ***Vinca Gordon*** capsized off the Dutch coast. They were injured while being rescued by a Dutch Navy helicopter in 50-kn winds with the vessel listing at 45°. The vessel narrowly missed several oil rigs and a light vessel before sinking near busy chipping lanes 12 mi off the Dutch coast. The tug/supply vessel ***Maersk Server*** (61°N, 2°E) lost all bridge windows and had only emergency power on the 29th. Other vessels that ran into difficulties during the storm included the ***Christianborg, Edith Borum, Lindeborg, Karen, Frederskborg, Cleaver Bank, Tabasco, Michelle*** and ***Signe***.

An International rescue operation involving two RAF Nimrods and at least seven helicopters from four countries took place on the 29th as North Sea trawlers and oil rigs were ravaged by this storm.

March, 1988—The most striking feature over the North Atlantic was a large summertime Azores-Bermuda High, which dominated a good portion of the Ocean, particularly in the west (fig 9). This resulted in pressure anomalies of up to +10 mb off Spain. The Icelandic Low was displaced slightly resulting in -4mb anomaly in the Labrador Sea and a -10 mb anomaly over southern Scandinavia. At the 700–mb level, steering currents were zonal from the U.S. to about 60°W and then curved sharply, cyclonically northeastward to about 30°W before turning east southeastward. This means an ideal storm starting in New York would end up in the English Channel.

On this date—March 19, 1956—The second heavy snowstorm to hit Boston, MA in just 3 days, buried nearby Blue Hill under 19.5 in of snow. It was the snowiest March of record for the area.

Extratropical Cyclones—Due to the blocking action of the Highs that made up the Azores High, storm tracks were concentrated mainly over the western portion of the shipping lanes this month. On the 25th and 26th heavy rains and thunderstorms rolled across the central Gulf of Mexico coast. Dime size hail was reported at Hattiesburg, MS while nearly 3 in of rain was measured at Mobile, AL and just over 2 in at Biloxi, MS.

❶ This storm developed over New Mexico on the 1st. It made its way slowly east northeastward and finally moved off the North Carolina coast on the 4th. It then turned northeastward and began to get organized. By 1200 on the 5th, off Nova Scotia, central pressure was down to 990 mb; 24 hr later it was at 964 mb. At 0900 on the 6th the ***Johan Petersen*** (59°N, 45°W) encountered 52-kn northeasterlies with a 972-mb pressure. Winds in the 40 to 45 kn range were common along with seas of 13 to 16 ft. The OXZM at 0000 on the 7th, near 60°N, 41°W, reported a 967-mb pressure in 44-kn southerlies. By this time the 964-mb center was moving in on Kap Farvel. Later in the day it was absorbed by another system in the Denmark St.

❷ This storm developed off the Virginia Capes on the 7th. Moving east northeastward, then northeastward it intensified into a 967-mb system by 1200 on the 9th. At 0000 on the 9th the ***Nedlloyd Rouen*** (40°N, 59°W) and the ***Sealand Voyager*** (40°N, 55°W) encountered 52 and 54 kn winds respectively with the former reporting 25-ft seas compared to 10 ft for the latter. By 1200 the ***Nedlloyd Rouen*** some 200 mi southwest of the center was reporting 63-kn westerlies in 16-ft seas. Six hr earlier the ***Sealand Voyager*** ran into 65-kn west northwesterlies. The ***Moordrecht*** some 120 mi south of the center, at 1200 on the 9th, battled 58-kn west southwesterlies in 26-ft seas and 38-ft swells. The Low continued to dominate weather over the western North Atlantic through the 10th when it began to weaken significantly.

❸ This Great Lakes storm began to organize on the 11th over Nebraska. By the morning of the 12th it had moved into extreme southeastern Minnesota spreading snow across the central part of the state and into northern Wisconsin and upper Michigan. While the storm wasn't huge it generated strong northerly winds, which were responsible for lake-effect snow squalls at many locations. Winds reached gale force over Lake Michigan. At Marquette, WI, snow began on the 11th and quit on the 15th. Over a period of 100 hr more than 38 in was recorded, in a season where 200 in has fallen through the 15th of March.

❹ On the 13th over northern Alberta, Canada a small Low developed in a trough. Over the next several days this rather inconspicuous system moved southward into the U.S. and even into Mexico by the 16th. On the 18th it entered the Gulf of Mexico east of Galveston. While creating some weather along the Gulf Coast it was not much of a system at this time compared to the following storm, which was dominating the north Atlantic. However, after moving into the western North Atlantic on the 19th it began to deepen. From 998 mb at 1200 on the 19th its pressure dipped to 967 mb 24 hr later and down to 956 mb by 1200 on the 21st.

At 1200 on the 20th the ***Atlantic Amity*** reported a 957-mb in 50-kn westerlies near 44°N, 63°W. The ***Concorde Caribe*** (44°N, 54°N) was belted by 60-kn westerlies in 15-ft

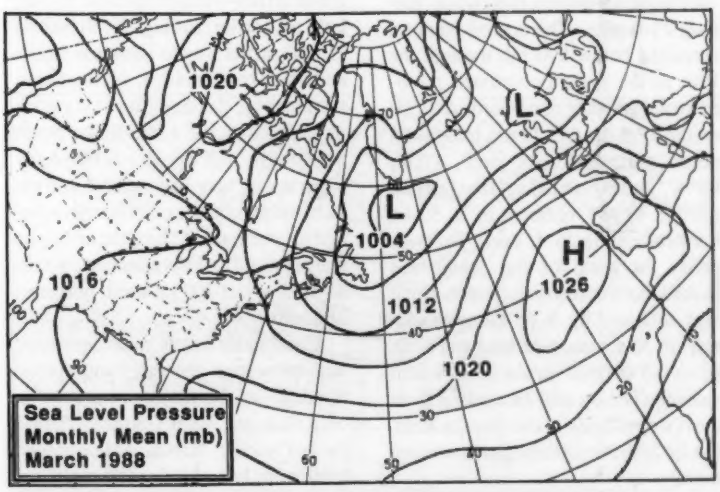

Figure 9.—Summertime in March by the looks of the Azores–Bermuda High.

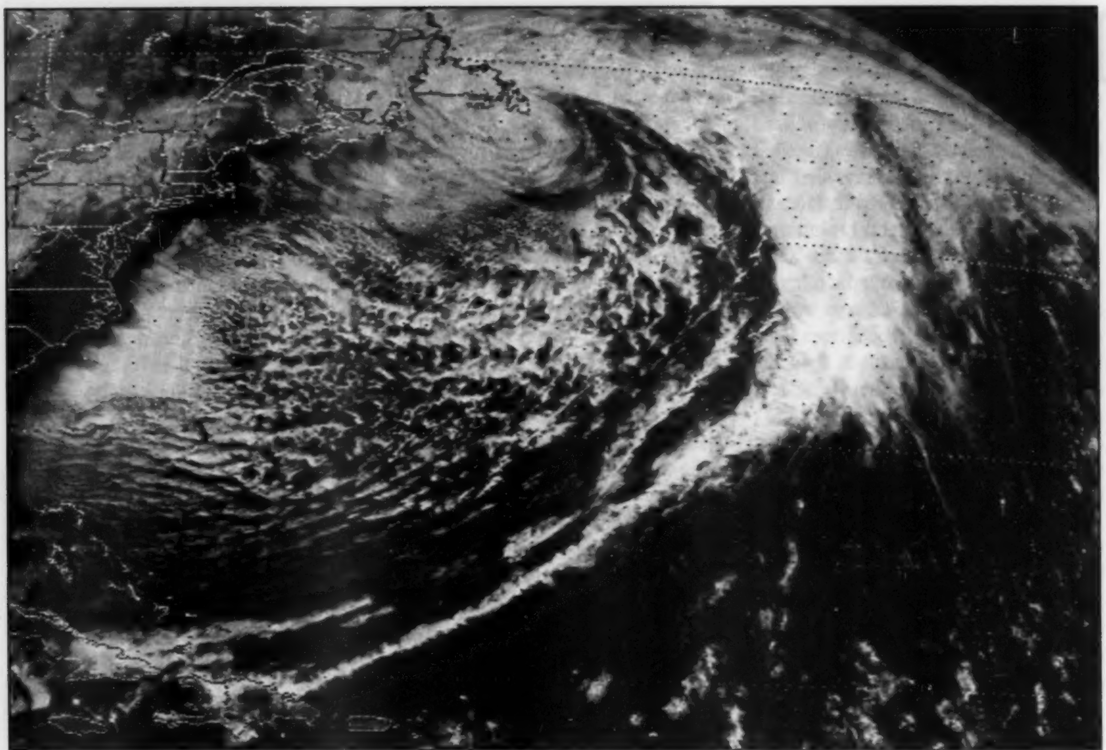

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Figure 10.—At 1430 on the 16th, this 958–mb storm dominates the western North Atlantic and its cold front extends into the Caribbean Sea.

swells. By 1800 winds in the 40 to 50 kn range were common in the storm's southern semicircle. Seas were running 8 to 20 ft. Gale and storm force winds continued through the 21st. Among the vessels reporting were the ***Narvskii Zalir, Fellow, Georgiv Ushakov***, and the ***Cyros***. At 1200 the ***Atlantic Companion*** (47°N, 41°W) ran into 63-kn west southwesterlies in 34-ft seas. This was a potent storm. At 1800 some 18 radio reports of gale or storm force winds were received. At 1200 on the 22d it was apparent that the 961-mb storm was turning a counterclockwise loop south of Greenland. During this turn it began to lose some of its potency. By the 24th pressure had risen to 994 mb.

❻ While the previous system was moving into Mexico on the 16th, this viscious storm was deepening to 958 mb just south of the Grand Banks (fig 10). This was a fall of 14 mb in 24 hr. Winds near the center were in the 40 to 50 kn range with seas of 13 to 23 ft. The ***Fossarina*** (45°N, 54°W) at 1200 reported a 969-mb pressure in 45 - kn west northwesterlies while battling 21-ft seas. The central pressure remained below 970 mb through the 19th as the system continued northeastward and then northward. At 0600 on the 17th the CG 28 ran into 58-kn north northwesterlies near 47°N, 58°W. At 1800 the ***Magnus Jensen*** (59°N, 43°W) radioed in a 52-kn northeasterly in 26- ft seas. This was pretty far north of the center and looked like a transmission error. But it was followed by a 65-kn northeasterly in 36-ft seas, 6 hr later and a 60-kn wind at 0600 on the 18th, which was matched by a 60-kn reading from the ***Nungu Ittak*** at the same latitude. On the 20th the storm began to weaken rapidly.

Tropical Cyclones—No tropical cyclones developed in the North Atlantic during March. This is not surprising since the last one was in 1908.

Casualties—The ***Capetan Elias***, bulk oil carrier, sailing for Sparrows Pt, MD on her way to Hampton Roads and then to Ymuiden, Netherlands, sustained ice damage after being stuck in pack ice on the 13th. In the North Sea on the 29th the ***Frederiksborg*** experienced very bad weather and put out a distress call as conditions continued to deteriorate. The three crewmen were rescued and it is assumed the vessel sank about 200 mi north northeast of Spain.

Continuous heavy rains combined with snow melt generated widespread flooding on the major waterways in both East and West Germany during the last week in March. At least seven lives were lost and flooded rivers included th Rhine, Danube, Elbe and the Main and their tributaries.

Marine Weather Review (cont'd)

North Pacific Weather Log
January, February and March, 1988

January, 1988—The North Pacific's reflection of winter storms, the Aleutian Low, was positioned nearly normal, but was more intense, by up to 13 mb, than usual. It can be reasonably expected that extratropical activity was plentiful and a look at the storm tracks for January confirms this. Steering currents at the 700–mb level were nearly zonal west of 170°E but curved cyclonically toward the northeast to the east. This means, ideally, that a storm over Tokyo would eventually cross Vancouver Is.

On this date—January 29, 1921—A small but intense storm resulted in the "Great Olympic Blowdown" in the Pacific Northwest. Hurricane force winds funnelled along the mountains and destroyed 8 billion board feet of timber. At North Head, WA wind reached 113 mph.

Extratropical Cyclones—While most of the Northern North Pacific was under the influence of winter storms, it was particularly active in the western Gulf of Alaska. One northeastern North Pacific storm on the 10th generated gales and heavy rains along the coast of Oregon. North Bend received nearly 3 in of rain in 24 hr.

In southern California a local storm generated strong winds and heavy surf. Sea level pressure at Los Angeles fell to its lowest level in 100 yr of record keeping, when it dropped to 990.5 mb on the 17th. At San Diego winds gusted to between 45 and 55 kn throughout the 17th (see Casualties).

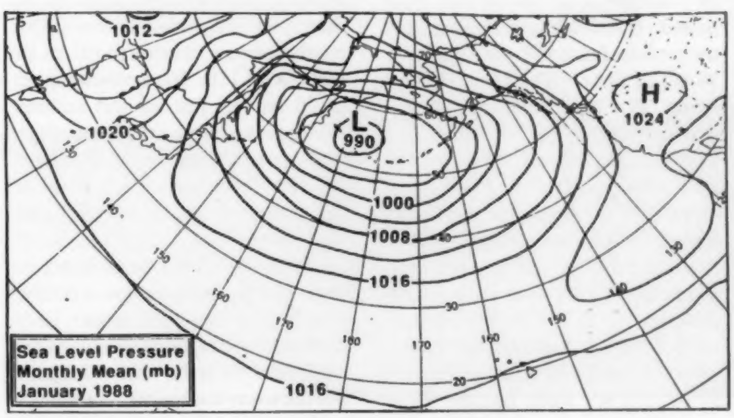

Figure 1.—An intense Aleutian Low dominates the North Pacific.

❶ A trough on the 4th, produced a weak Low pressure center off Tokyo. It moved northeastward and organized. By 1200 on the 5th its circulation was wrapped around a 970-mb center and it was generating storm force winds. This was testified to by the ***New Diana*** and the ***Waardrecht,*** which encountered 52 and 50 kn respectively. The ***Richfield*** came in with a 976.3-mb pressure in 40-kn winds. However, within 24 hr the central pressure fell another 14 mb to 956 mb, as the system headed toward the Gulf of Alaska (fig 2). At 0600 on the 6th the ***Young Soldier*** (46°N, 176°W) hit 65-kn west southwesterlies with a 975-mb pressure while battling 33-ft swells. Storm force winds were encountered by the ***Young Slope, Richfield, Giovanni,***

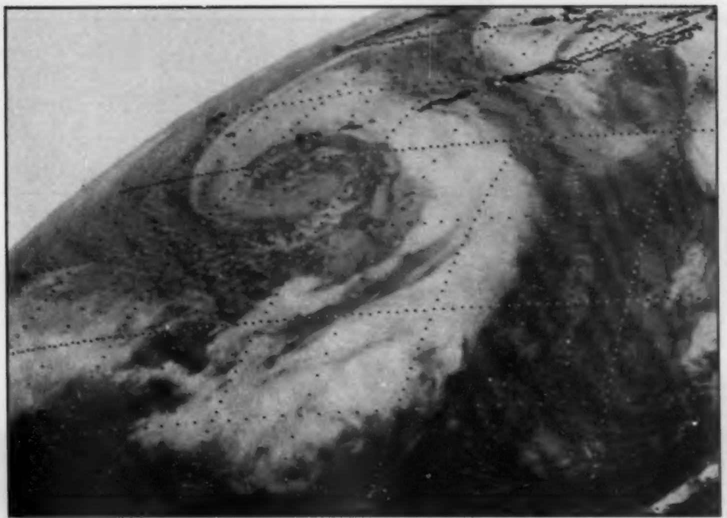

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Figure 2.—This potent 956-mb storm was heading for the Gulf of Alaska at 1116 on the 6th.

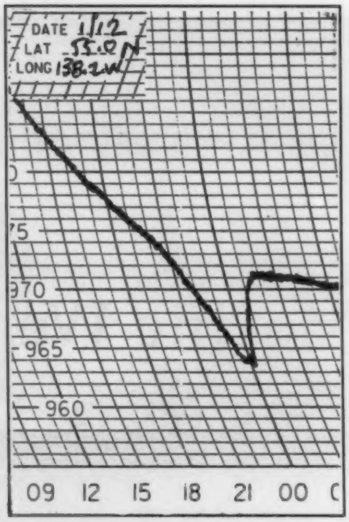

Figure 3.—The ***Overseas Chicago*** *recorded this pressure on the 12th.*

Sanyo Maru, Senyo Glory and the ELEK. On the 7th the storm turned northward and began a counterclockwise loop over the Alaska Peninsula. However, it refused to die and eventually was reinforced by the next system. It managed to hang on until the 17th after crossing the Alaska Peninsula one more time on the 14th as a 968-mb Low.

❷ This storm developed on the 9th as a wave along a front associated with another storm, which flared up briefly in the southern Bering Sea. This system became part of a troika, from the 11th through the 13th, which dominated the weather over a good portion of the North Pacific. This particular storm was the dominant center on the 12th, at 1200, when its pressure dropped to 954 mb near 50°N, 150°W (fig 3). The ***Belkino***, some 200 mi to the west, ran into 54-kn northwesterlies. Six hr later the KGTY (57°N, 150°W) reported 45-kn easterlies with a 974-mb pressure while battling 25-ft seas. The storm was now beginning to fill while recurving in the Gulf of Alaska. It finally merged into the previous storm on the 14th.

❸ On the 18th, this storm came to life east of Tokyo. Moving east northeastward it intensified rapidly. At 0000 on the 19th the ***Yoho Maru*** (39°N, 169°E) reported a 967-mb pressure, a good indication of how quickly this system was developing. By 1200 it was generating gales out to 1200 mi in its southwest quadrant, where swells were being reported to 33 ft. The ***George Washington Bridge***, about 650 mi southwest of the center, at 0000 on the 20th, ran into 53-kn west northwesterlies in 31-ft seas; they had a slope of about 1/10. The associated cold front was also quite active. The ***Venus Diamond*** some 700 mi to the south of the storm's center was blasted by 68-kn westerlies as the front passed. By 1200 on the 20th the central pressure fell to 938 mb— a drop of 18 mb in 24 hr. The ***Maersk Tacoma*** (49.9°N,173.6°W) at 0600 reported a 956.5-mb pressure with 51-kn northeasterlies in 30-ft seas. The ***Red Arrow***, at the same time, near 48°N, 176°W, registered a 959-mb reading in 43-kn northerlies. By 0000 on the 21st the ***Maersk Tacoma*** was still battling 54-kn winds but seas had slackened to 12 ft. This wind was verified by the ***Star Hong Kong***, which reported a 52-kn westerly, near 37°N, 173°W, while battling 18-ft seas. The storm began to fill on the 21st but remained potent as it moved into the western Gulf of Alaska. It moved ashore on the 22d.

Tropical Cyclones—Of the 17 January tropical cyclones that have developed over the western North Pacific since 1959, Roy became the eighth typhoon. This also marks the second year in a row that a typhoon has formed in January.

Roy was christened on the 8th when he was upgraded from td 01w, near 8°N, 170°E. The tropical storm moved westward and intensified. By 1200 on the 9th Roy reached typhoon strength as his central convection organized. He remained south of the subtropical ridge as winds near the 20-mi diameter eye climbed to 105 kn, by early on the 11th. His westward speed of 20 kn was fast for this latitude. Winds peaked at about 110 kn early on the 11th and remained there through the 12th. Roy passed just north of Guam on the 12th lashing the island with 117-kn gusts and 20-ft storm tides (fig 4). Early damage estimates were were put at $ 6 million to homes, tropical fruit crops and roads. Only one injury was reported. Earlier in the week the typhoon had claimed at least one life when it raked the Marshall Islands.

Roy weakened slightly, but winds

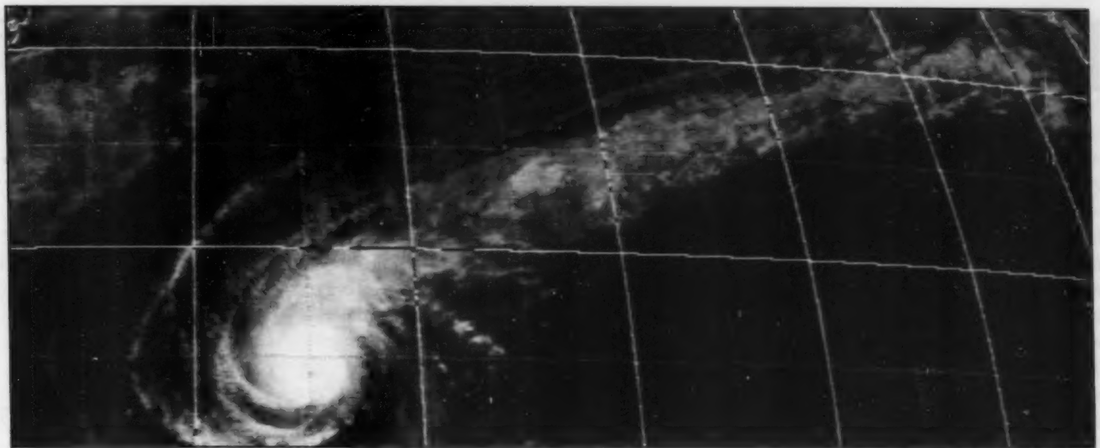

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Figure 4.—Typhoon Roy was blasting Guam at 0900 on the 12th as winds near his center were estimate at 110 kn.

remained at 100 kn or more until the 14th. He was a typhoon until the 16th when he hit the northern Philippines. Moving across southern Luzon, Roy dropped to tropical storm strength on the 16th and to depression intensity the following day.

Casualties— During Roy at Guam the ***Windjammer*** sunk and the yacht ***Marishitten***, the vessels ***Seiho Maru No. 58*** and ***Kazutaka Maru No. 8*** were driven aground. Off the Japanese coast on the 4th a fishing vessel rescued 59 people from Indian -flag cargo ship ***Vishra Anurag*** when she capsized in rough seas. The ***Pacific Beauty***, from Osaka to Pusan, South Korea was carried away by rapid tidal currents and ran on shallows on the 15th.

The Southern California storm, on the 17th, claimed seven lives as it spread snow across the southwest after lashing the coast with strong winds and rough surf. In Redondo Beach, where a state of emergency was declared, damage to the waterfront was estimated at $21 million (fig 5). In Huntington Beach waves took out a 250–ft section of the pier. The world–famous San Diego Zoo, which was forced to close, sustained $175,000 damage. In addition a light plane crashed in the foul weather, into a fog–shrouded mountain, killing four members of the Los Angeles County Sheriff's Department.

At Ensenada the ***Andromeda*** and the ***Guaymas*** sustained heavy damage in the storm. The passenger vessel ***Polaris*** from San Diego arrived at Ensenada late on the 17th only to depart for Todos Island to seek shelter from the storm. The tug ***Cindy Cenac*** was driven aground at Ensenada on the 17th, while the ***El Sargacero*** suffered storm damage as well.

Wide World

Figure 5.— A lone surfer braves the waves after a strong storm passed through southern California on the 17th. Several buildings along the coast were damaged and the rampaging tides closed many coastal roads.

February,1988—While the Aleutian Low dominates the February climatic charts, this year it pressed that fact home (fig 6) with anomalies that ranged up to -17 mb near 50°N, 170°W. This was easily the most impressive feature. However, the subtropical high pushed farther to the northeast than normal, and more intense than usual, created +8 mb anomalies in the Pacific Northwest. The steering currents at 700 mb were nearly zonal from Japan to the Dateline and then curved cyclonically northeastward over the eastern Pacific and Gulf of Alaska. This means, ideally, that a storm over Tokyo would wind up in southeast Alaska.

On this date—February 10, 1978—Up to 8 in of rain fell over Southern California resulting in widespread flooding and mudslides. The heavy rain produced a wall of water, which ripped through the mountain resort community of Hidden Springs drowning at least 13 people. Damage was estimated at $50 million.

Extratropical Cyclones—A glance at the storm tracks will tell you where all the action was in the Pacific this month and which areas got off lucky. From the western Gulf of Alaska southwestward things were hot while the eastern Gulf of Alaska fared pretty well.

In southern California a Santa Ana wind, although not necessarily extratropical in nature, caused havoc on the 19th. Four deaths were blamed on the storm with another person missing at sea. Winds gusted to 78 kn leaving a half million people temporarily without power.

❶ This was no simple storm but a combination and merger of several centers. It originally began on the 1st near 35°N, 167°E. This center moved east northeastward then recurved northward. Meanwhile another center had developed over the Aleutians on the 2d and headed southeastward. On the 2d, near the lst center, the ***Lisa Maersk*** ran into 47-kn south southwesterlies in 20-ft seas. The two centers merged on the 3d. The following day the central pressure was down to 966 mb. At 0600 on the 3d a vessel with an ELFV call sign was nailed by 51-kn westerlies near 44°N, 166°W. At 1800 the ***Sealand Independence*** (48°N, 169°W) reported a 973-mb pressure, while battling 30-ft seas, with a slope of about 1/6—very steep; winds at the time were blowing from the west at 44 kn. This excellent report was instrumental in helping to determine the character of this system. The storm was zig zagging its way northward. On the 5th it combined with another center as it approach the eastern Aleutians. Another center was located over the eastern Gulf of Alaska. Winds in the Gulf were ranging from 40 to 45 kn. Several other centers were found to the south and west and this kept things active in the region until the 7th.

❷ The ***Zim Montreal***, near 36°N, 173°E, on the 16th at 0600, reported a 42-kn easterly with a 979-mb pressure. This report pinpointed the center of a developing Low that was to become one of the deepest storms of the month. By 1200 the central pressure was down to 966 mb and 24 hr later, at 1200 on the 17th, it had plummeted to 952 mb. The ***David Packard*** and the BKHW confirmed the intensity of this storm. Both reported a 963-mb pressure while the former encountered 60-kn winds and the latter 52-kn southerlies; at 0000 they were within 120 mi of the center. At 0600 the ***Verrazano Bridge*** reported a 969.5-mb reading in 51-kn southerlies near 45°N, 169°W. By the 18th the rapidly moving 966-mb center was across the Alaska Peninsula and accelerating north northeastward. The following day it moved into eastern Alaska and weakened.

❸ This storm began on the 18th near 33°N, 155°E. It moved east northeastward for a couple of days while getting itself organized. By the 20th at 1200, it was a 985-mb Low and was turning northward. Some 24 hr later its central pressure had dropped to 952 mb in vicinity of the previous storm's lowest pressure. At 0600 an unidentified vessel just south of the center reported 50-kn westerlies with a 977-mb pressure in 16-ft swells. At 1200 the vessel was nailed by 64-kn north northwesterlies while reading a 970-mb pressure, near 41°N, 176°W. That, surprisingly, was the only report of significance to be received at 1200 from a potent storm in the middle of major shipping lanes; not much for forecasters to go on (fig 7). This same unidentified ship reported over a period of 2 days to help establish the character of this dangerous storm. At 0000 on the 21st, finally, the ELHB reported 52-kn easterlies east of the

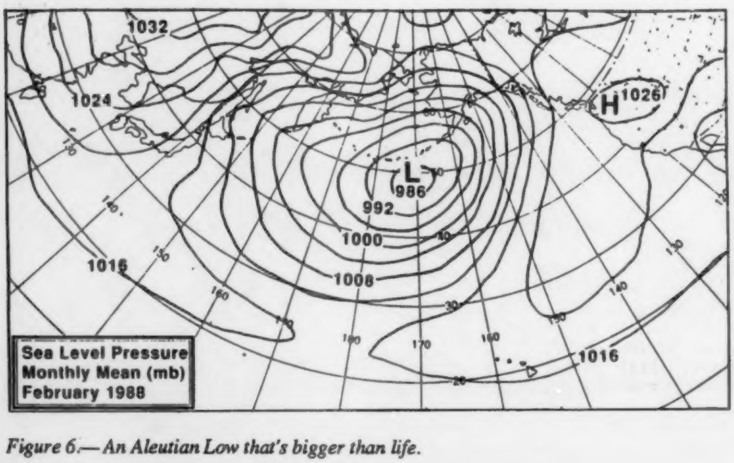

Figure 6.—An Aleutian Low that's bigger than life.

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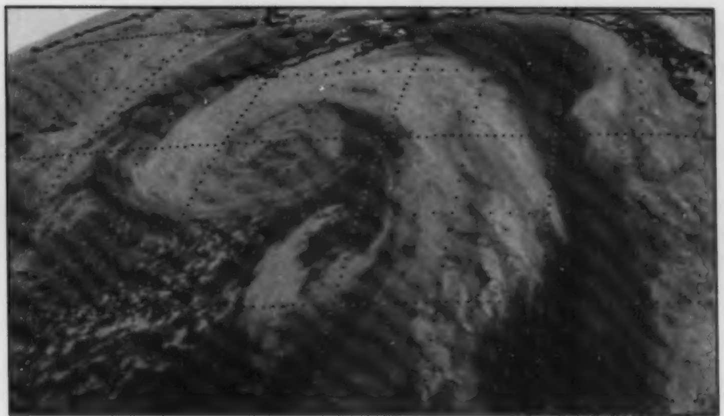
Figure 7.—Ship reports were lacking near this storm (1046 on the 21st).



Satellite Applications Branch

Figure 8.—At the time of this storm's peak forecasters had to rely on this satellite photo at 0916 on the 24th.

storm's 958-mb center. The system remained potent through the 22d as it slowed and meandered just south of the Aleutians.

➒ On the outskirts of the previous storm's circulation, on the 22d, this system sprung to life near 35°N, 170°E. It moved in a parabolic arc into the Gulf of Alaska by the 24th. Along the way, however, the bottom dropped out. On the 23d at 1200 it was one of four centers of low pressure over the eastern North Pacific. Its central pressure was estimated a 978 mb. By 1200 on the 24th its central pressure was down to 948 mb— a drop of 30 mb in 24 hr. This explosive deepening is extremely dangerous to shipping. Gales and storm force winds were already blowing by 1800 on the 23d. The ***Neptune Jade*** (43°N, 162°W) reported a 967.7-mb reading in 52-kn southerlies and 25-ft seas. By 0000 on the 24th her winds increased to 55-kn while the ***Fort Dufferin*** (44°N, 158°W) hit 65-kn southwesterlies with a 979-mb pressure in 23-ft seas. Several other ships hit winds in the 50 to 55 kn range. The lowest reported pressure was 968 mb by the ***President Pierce*** near 46°N, 156°W in 54-kn south southwesterlies. Four hr later the HPW1 (47°N, 159W°) reported a 960-mb pressure just west of the center. Reports were lacking at 1200 (fig 8), the time of the storm's peak. Gales continued to blow into the 25th as the storm began to weaken. It crossed the Alaska Peninsula at 1200 with a 973-mb pressure.

Tropical Cyclones—No tropical cyclones developed over the North Pacific in February. They are most likely in the west where nine have developed since 1959.

Casualties— There were no reports received by this office. However the ***Windjammer***, which sank at Apra Harbor on the 12th of January during Roy, was safely on blocks in dry dock by the 9th of February.

March, 1988—The Aleutian Low was deeper than normal and its center was displaced eastward to the Alaska Peninsula (fig 9) resulting in negative anomalies up to -10mb in the Gulf of Alaska. The subtropical high was deeper and more extensive than normal resulting in a +7mb anomaly off the coast of Washington and British Columbia and 2 to 3 mb in the central Pacific waters south of 30°N. The steering currents at the 700 mb heights were nearly zonal between 30°N, and 45°N except east of 160°W where they curved sharply toward the northeast-

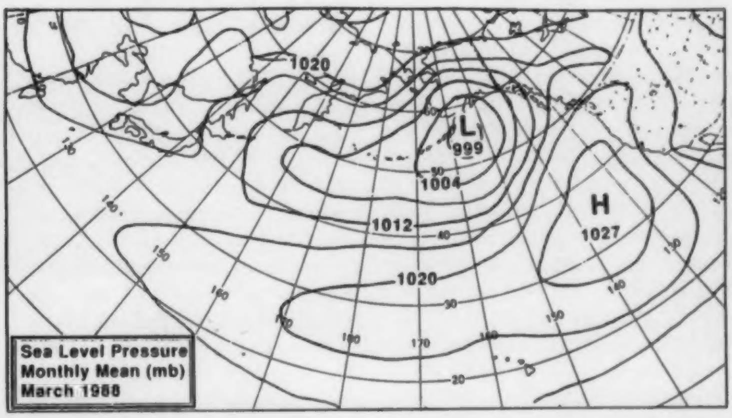


Figure 9.—Both the Aleutian Low and the subtropical high were more intense than normal.

ward toward the Gulf of Alaska and northwestern U.S.coast. Under ideal conditions a storm off Tokyo might end up over Vancouver Is.

On this date— March 12, 1967—A tremendous 4-day storm was raging over California. The storm produced 86 in of snow in 60 hr at Squaw Valley. Winds of 80 kn closed mountain passes while heavy rains flooded the lowlands.

Extratropical Cyclones—The storms were concentrated in an east northeastward band north of 35°N, stretching from southern Japan to the Gulf of Alaska. The Gulf, in particular, was a behive of activity throughout the month. On the 22d a cold front along the Washington coast was responsible for wind gusts up to 70 kn at Ocean Shores. Cape Disappointment clocked gusts to 65 kn and Quillayute WA measured 1.63 in of rain in 24 hr.

❶ This storm was spotted on the 1st just south of Shikoku, Japan. It meandered toward the east northeast as it developed over the next few days. By the 4th it became organized into a 984-mb Low near 43°N, 167°E. Ships to the south and southwest were encountering gales and rough seas. The ***Balancha***, near 45°N, 150°E at 0000 on the 4th, reported 54-kn northerlies but most reports were in the 40 to 45 kn range. However by 0000 on the 5th ships reporting storm force winds included the ***Chikubu Maru, Melampus, Pacmajesty*** and the ***Tai an hai***. Seas were running about 15 to 30 ft. By 1200 the 973-mb center was crossing the 45th parallel near 175°E and continuing to deepen. The following day pressure dipped to 960 mb. Before the day was out the system was absorbed into a new center closer to the western Gulf of Alaska, which was measured at 964 mb. All that mattered to the ships at sea however was that winds were still blowing at 40 to 45kn in 10-to 15-ft seas. On the 7th the 974-mb storm moved into the northern Gulf of Alaska and slowed. The following day it moved inland near Anchorage.

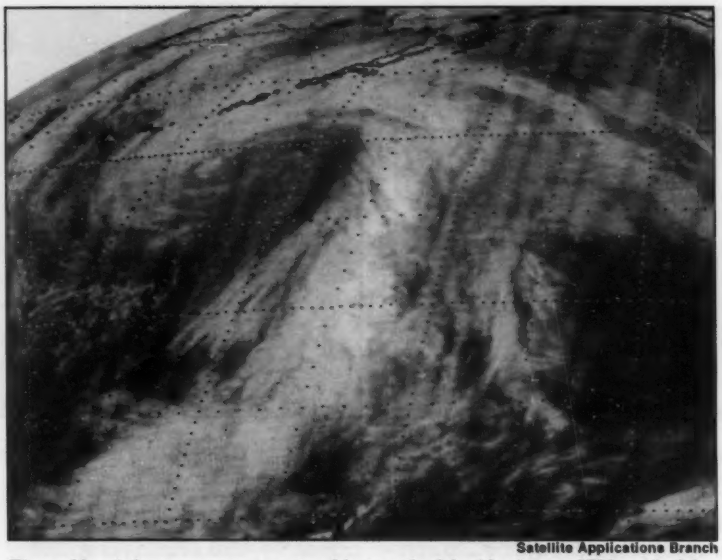


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Figure 10.—A dangerous storm centered just south of the Aleutians at 0718 on the 9th.

❷ Meanwhile another storm had came to life on the 6th near 41°N, 155°E. By the 8th it had a 990 mb center that was about to turn northeastward after crossing the Dateline. The central pressure may have been lower at 1200 but there were no reports in the vicinity. However at 1800 the ***Kitaura Maru*** reported a 966-mb reading close to the center, indicating this storm was deepening rapidly. The ***Melampus*** (40°N, 166°W) measured a 45-kn southerly in 23-ft seas. By 0000 on the 9th pressure was down to 958 mb and 12 hr later it was at 952 mb. The ***Lica Maersk***, near 51°N, 168°W at 0600, encountered a 65-kn northeasterly with a 972-mb pressure (fig 10). The storm remained potent through the 10th as its center turned northward and crossed the Alaska Peninsula. At 1800 on the 9th an unidentified ship near 53°N, 165°W reported a 957.3-mb pressure with winds from the north northeast at 54 kn in 20-ft seas. Storm force winds were also reported by the ***Kizir*** and the ***Paoudja***. Four reports of storm force winds came in at 0000 on the 10th and seas up to 30 ft were being encountered east of the storm center. By the 11th the Low was overland heading for the Seward Peninsula but still generating gales over the Gulf of Alaska. At 1200 the ***Vityaz*** (50°N 156°W) ran into 50-kn southeasterlies, as a second center took over and kept things hopping through the 12th.

❸ This short-lived but potent storm had first developed as an atmospheric wave, along a front, north of Korea on the 10th. It wasn't until early on the 12th that it became organized into a recognizable storm system with a 982-mb center in the Sea of Japan. The Low developed rapidly from this point and became a danger to ships along the western North Pacific routes. By 1200 central pressure had dropped to 974 mb and 40-to 45-kn winds were being encountered south and southeast of the center. At 1800 the ***Nedlloyd Leuve*** and ***Poseidon***, about 750 mi south of the center, ahead of the cold front hit 50-kn southerlies in 13-ft seas. The storm continued to deepen as it moved south of the Kamchatka Peninsula. By 1200 on the 13th the pressure was down to 962 mb. A flood of reports indicated that winds ranged from 40 to 64 kn in seas up to 16 ft. The ***Daiho Maru*** (50°N, 158°E) reported 64-kn east northeasterlies and a 970-mb pressure, while the ***Konstitoutsiya SSSR*** was battling 62-kn northeasterlies near 52°N, 156°E. The

lowest pressure reported was a 968 mb near 50°N, 155°E by the ***Valentine Kotelnikov***. The storm peaked at about 960 mb at 1800. However, it remained potent through the 14th as it turned northward and moved into the western Bering Sea the following day.

❶ Monster of the Month—While the previous system was raging on the 14th, this storm was making its initial appearance over Shikoku. It tracked northeastward and by the 15th, at 1200, was a 974-mb storm and developing rapidly. By 0600 on the 16th (fig 11) the central pressure had plummeted to an estimated 948 mb, with the center located just east of the Kuril Islands. At 1800 on the 15th the 3EZM, near 45°N,151°E, reported a 968-mb pressure and 58-kn west northwesterlies. The ***Francis Sincere No. 6***, near 49°N, 156°E at 0000 on the 16th, read a 957.9-mb pressure while the ***Zakharovo*** (49.5°N 154.3E) supported this with a 954.4 mb pressure in 70-kn southwesterlies and 26-ft seas. Storm force winds were common and included seven reports of 60 kn or above. The ***Fort Dufferin***'s winds climbed to 78 kn at 0300 while still battling 26-ft seas with a slope of about 1/12; her pressure was 962 mb. The ***Belkino*** (51°N, 157°E) also had a 962-mb pressure with a 64-kn east wind at 0600. The storm continued to rage as it moved northward but hurricane force winds dropped to storm force late on the 16th. On the 17th pressure readings rose into the 970-mb range and winds dropped to gale force. The former monster turned over the Kamchatka Peninsula and died.

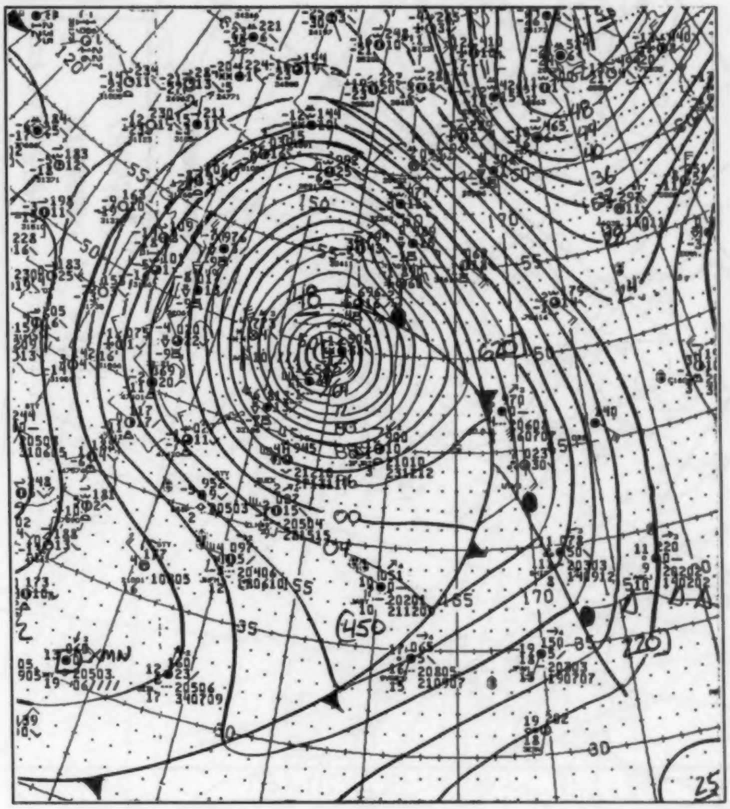


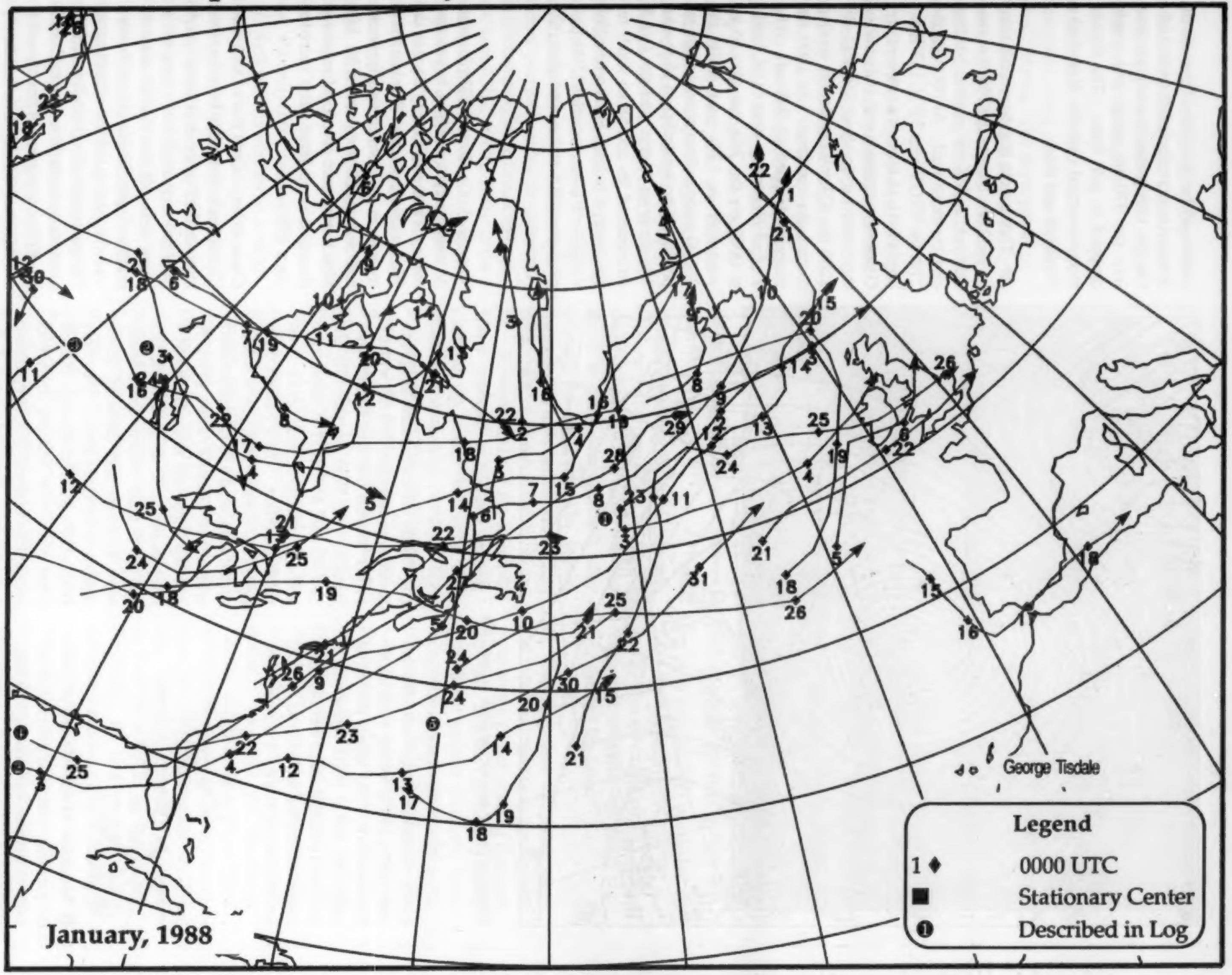
Figure 11.—The monster at 0600 on the 16th.

❻ This system began over Shikoku on the 25th. Late on the 26th it organized into a 988-mb system, heading east northeastward. At 0000 on the 27th the VRGY near 35°N, 153°E encountered a 44-kn west southwesterly. Gales were common east and south of the center out to about 450 mi. By 1200 the 973-mb center was turning toward the northeast. At 1800 the pressure dropped to 966 mb. The ***Tokyo Highway*** near 41°N, 168°E at 0000 on the 28th ran into 55-kn westerlies in 13-ft seas while the 3EMG a short distance away was reporting 66-kn westerlies in 16-ft seas. The ***Kenryu Maru*** and the ***Act 9*** encountered 56- and 58-kn winds respectively 6 hr later. Early on the 29th the 980-mb Low crossed the 50th parallel near 180° and moved along the Aleutians.

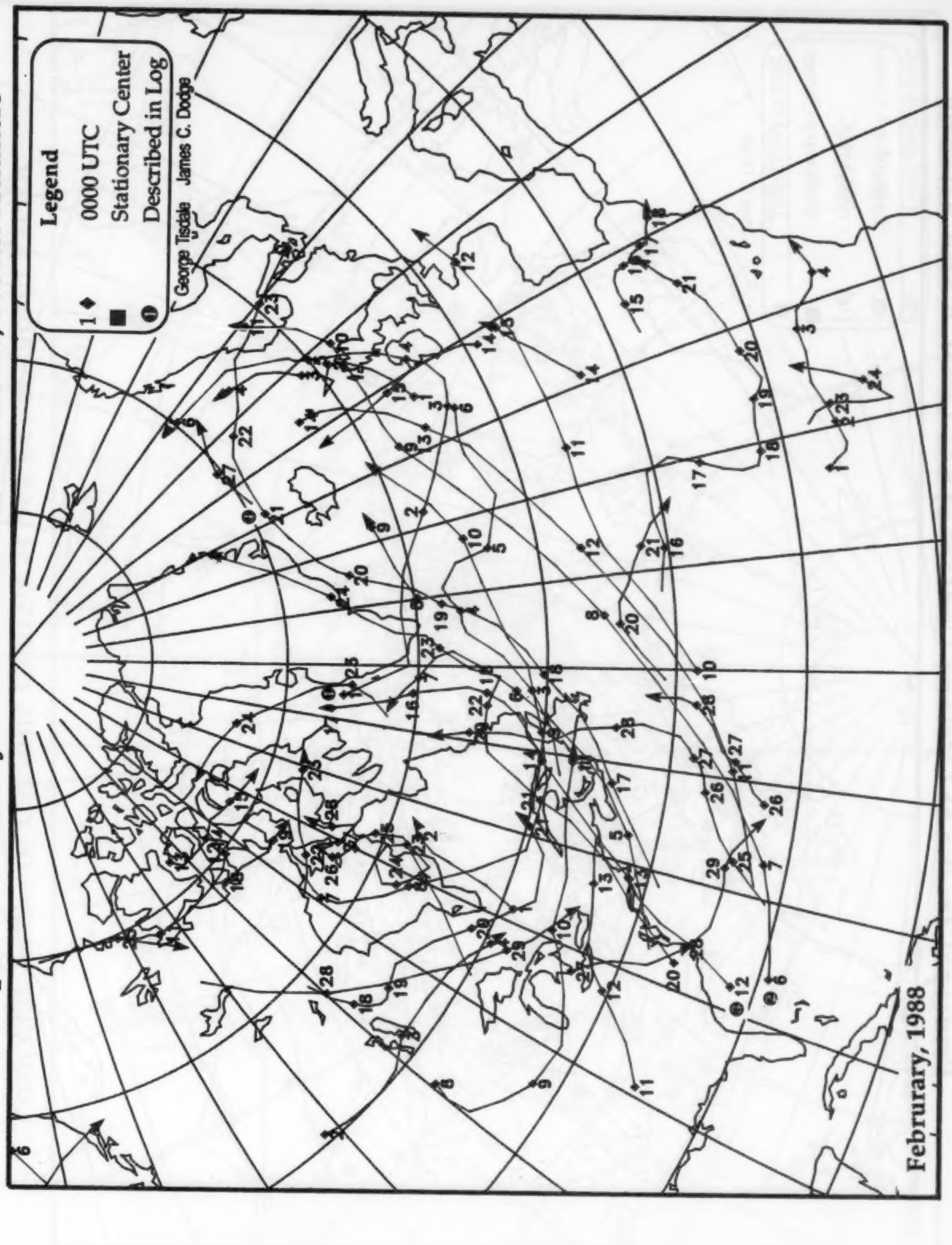
Tropical Cyclones—There were no tropical cyclones in a month that averages about one every 2 yr in the Western North Pacific. The last activity was in 1982 when two typhoons and a tropical storm came to life. March storms are even less frequent in the east; none have been recorded since 1966.

Casualties —Only one of a crew of 22 seamen is thought to have survived after a Philippine-registered cargo ship ran aground and capsized in storm seas off the Pacific coast of northern Japan. The ***Captain Trader*** was on passage from Hakodate to Shiogama and ran aground on the 22d, overturning in shallow waters about 2 mi off Shiogama port. The only survivor said that the ship listed suddenly and everyone was thrown overboard. Fifteen bodies were recovered at last report.

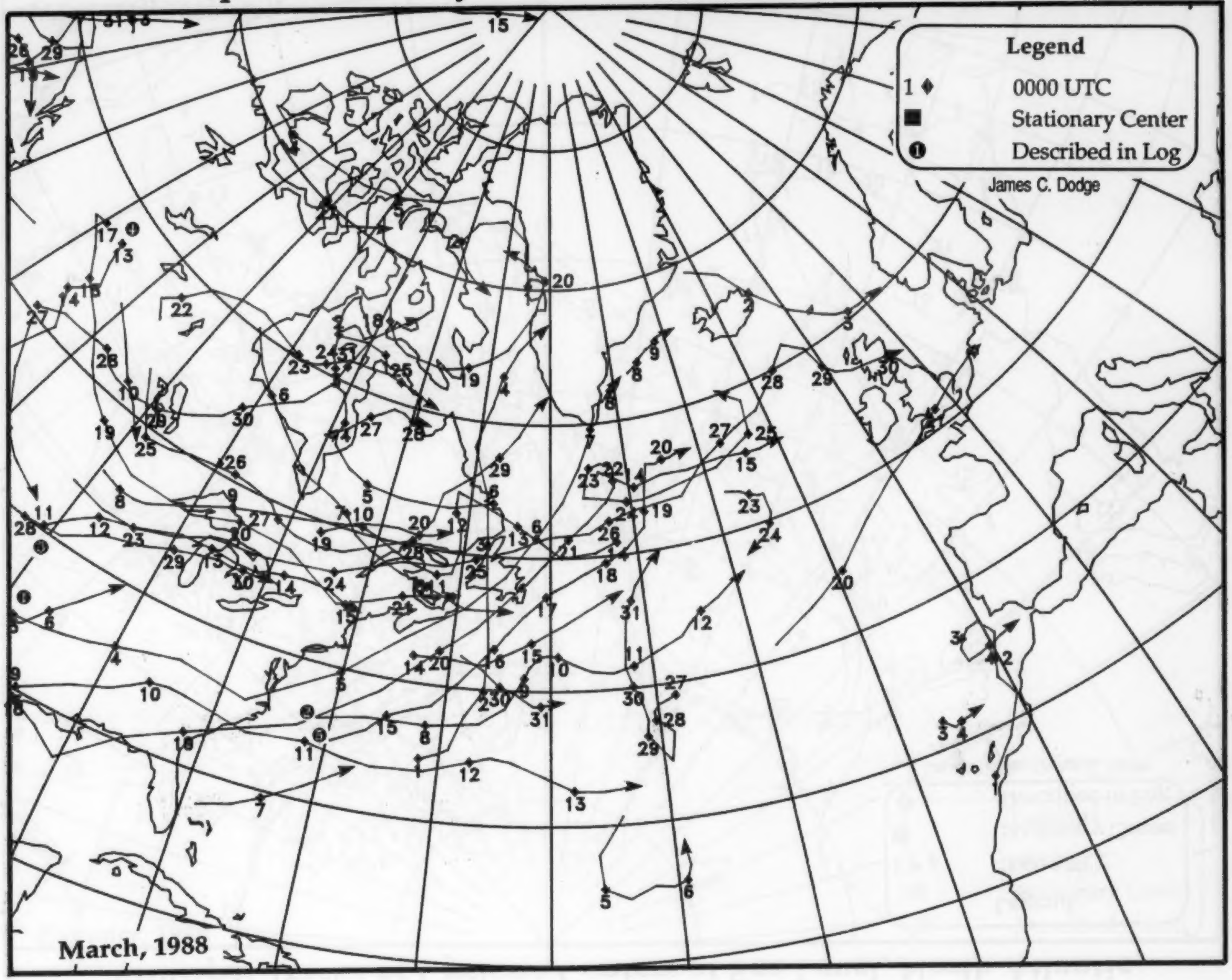
Principal Tracks of Cyclone Centers at Sea Level, North Atlantic



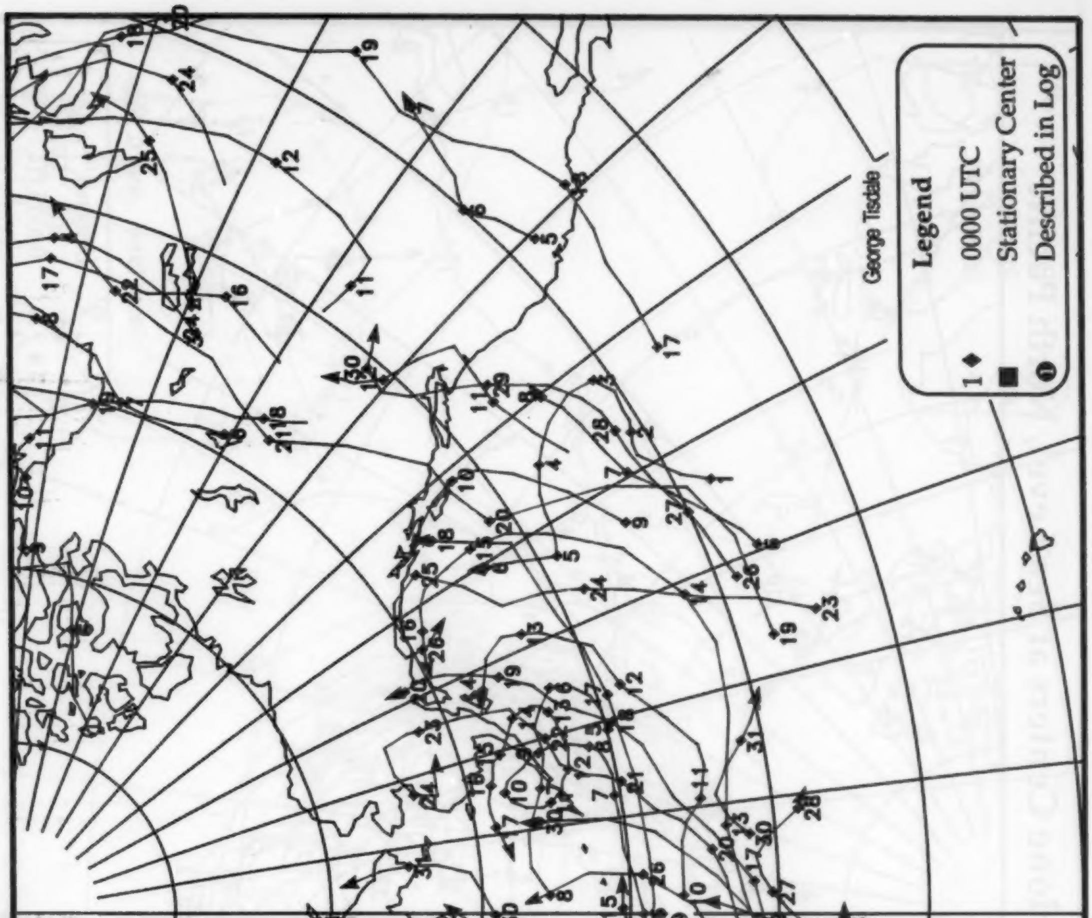
Principal Tracks of Cyclone Centers at Sea Level, North Atlantic



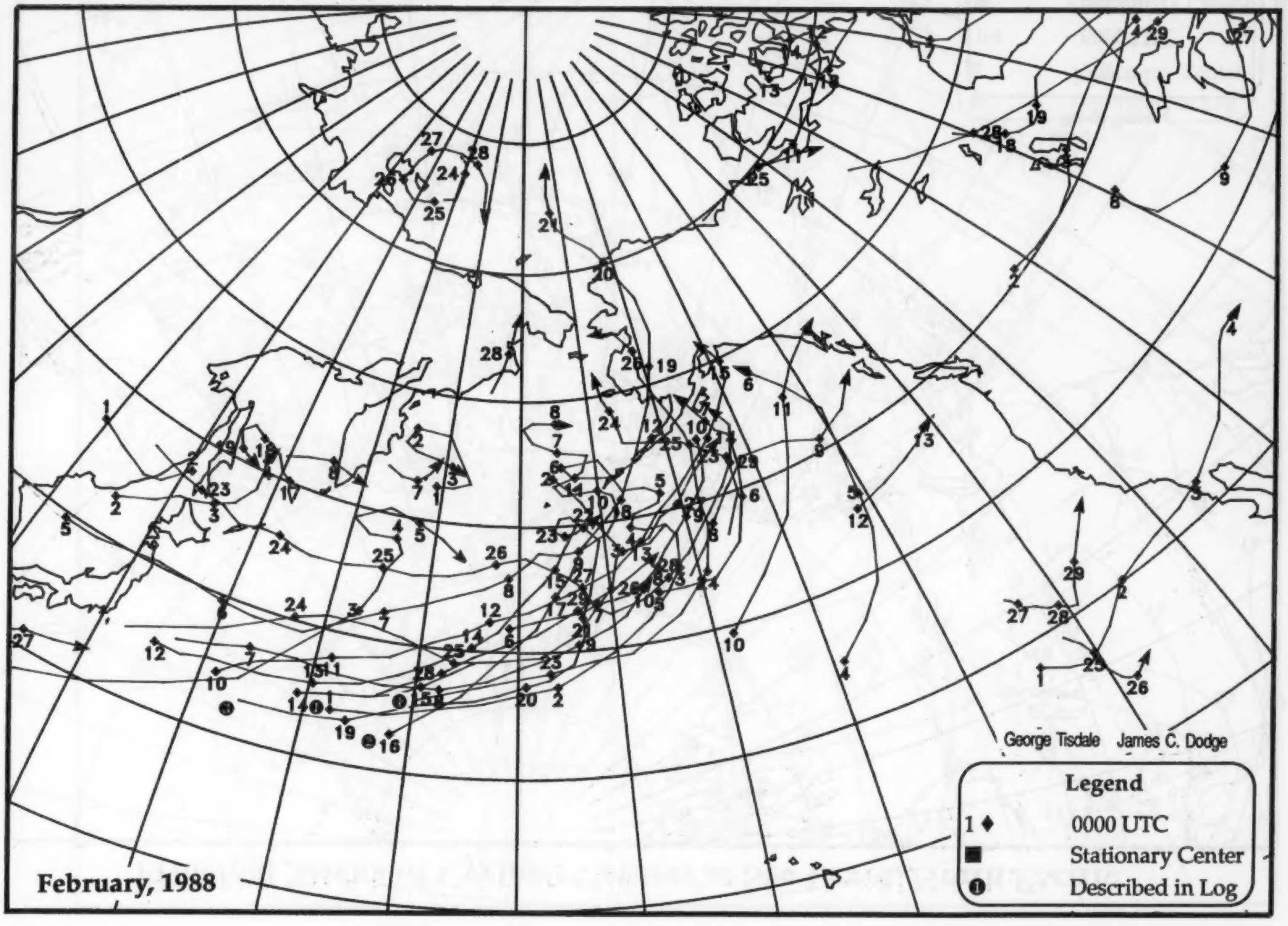
Principal Tracks of Cyclone Centers at Sea Level, North Atlantic



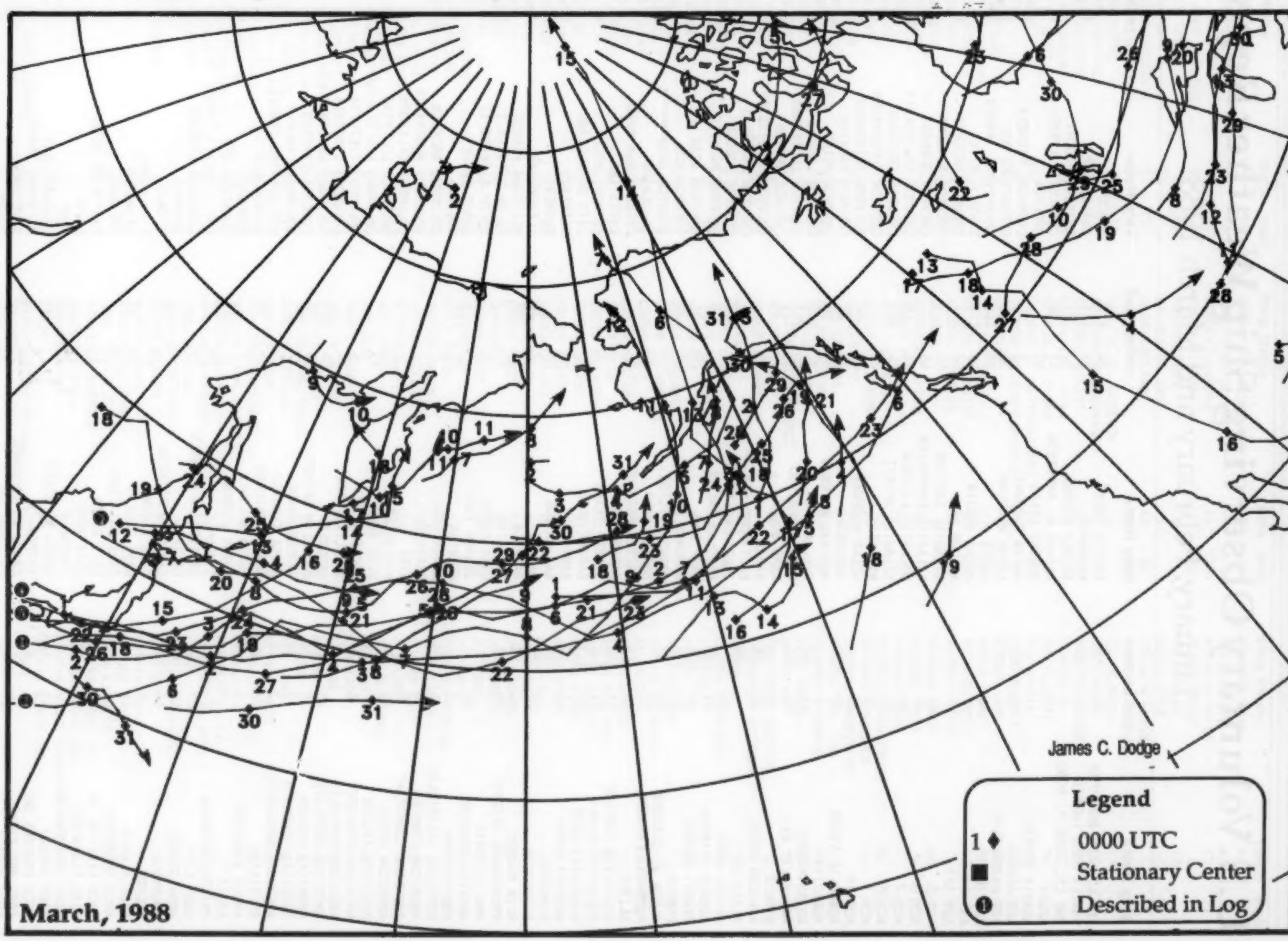
Principal Tracks of Cyclone Centers at Sea Level, North Pacific



Principal Tracks of Cyclone Centers at Sea Level, North Pacific



Principal Tracks of Cyclone Centers at Sea Level, North Pacific



U.S. Voluntary Observing Ship Weather Reports

January, February and March 1988

Ship Name	radio	mail
1ST LT ALEX BONNYMAN	20	19
1ST LT JACK LUMMIS	6	38
2ND LT. JOHN P. BOBO	8	
ABBEY	110	
ACADIA FOREST	31	
ACE ACCORD	84	162
ACE ENTERPRISE		67
ACT 10	28	
ACT 11	11	
ACT 111	95	
ACT 5	124	
ACT 6	79	
ACT 7	99	
ACT 9	61	
ACT I	73	
ACT IV	53	
ADABELLE LYKES	29	120
ADDIRIYAH	4	
ADIAN MAERSK	11	67
ADMIRALTY BAY	50	176
ADONIS	10	
AFRICAN FERN	26	73
ALAIN LD		50
ALASKA MARU	55	
ALASKA RAINBOW	43	217
ALBERT MAERSK	29	104
ALBULA	37	138
ALDEN W. CLAUSEN	26	63
ALEMANIA EXPRESS	58	
ALISON	18	46
ALLIGATOR FORTUNE	43	50
ALLIGATOR GLORY	33	161
ALLIGATOR HOPE	69	147
ALMERIA LYKES	41	92
ALMUDENA		45
ALTAMONTE	28	81
ALVA MAERSK	45	92
AMBASSADOR BRIDGE	20	84
AMELIA TOPIC	5	
AMERICA EXPRESS	36	
AMERICA SUN	2	
AMERICAN CALIFORNIA	3	58
AMERICAN CONDOR	8	
AMERICAN CORMORANT	8	
AMERICAN EAGLE	46	33
AMERICAN FALCON		145
AMERICAN KENTUCKY	3	20
AMERICAN REPUBLIC		7
AMERICAN RESOLUTE	45	74
AMERICAN TROJAN	15	28
AMERICAN VIRGINIA	7	20
AMERICAN WASHINGTON	2	36
AMERICANA	26	89
AMOCO YORKTOWN	4	8
ANITA	3	
ANTHONY RAINBOW	21	119
AQUA CITY	101	253
AQUA GARDEN	49	95
AQUARIUS	64	137
ARCHON	8	45
ARCO ALASKA	27	46
ARCO ANCHORAGE	6	28
ARCO CALIFORNIA	25	40
ARCO FAIRBANKS	23	28
ARCO INDEPENDENCE		8
ARCO JUNEAU	10	16
ARCO PRUDHOE BAY	37	39
ARCO SAG RIVER	24	17
ARCO SPIRIT	33	24
ARCO TEXAS	12	16

Ship Name	radio	mail
ARCTIC TOKYO	24	178
ARGONAUT	29	151
ARNOLD MAERSK	10	21
ARTHUR M. ANDERSON	47	88
ASHLEY LYKES	17	
ASIAN HIGHWAY	6	
ASIAN VENTURE	32	
ASPEN	38	148
ASTRO JYOJIN	23	112
ATIGUN PASS	108	291
ATLANTIC CARTIER	14	
ATLANTIC COMPANION	45	
ATLANTIC RAINBOW	26	40
ATLANTIC SPIRIT	74	196
ATLANTIS II	20	
ATLAS HIGHWAY	79	48
AUSTANGER	18	37
AUSTRAL RAINBOW	29	95
B.T. ALASKA	34	132
B.T. SAN DIEGO	80	283
BAAB ULLAH	18	38
BAJKA	4	
BALTIMORE SEA	9	
BALTIMORE TRADER	45	132
BANGLAR KALLOL		8
BAR' ZAN	29	51
BARBARA ANDRIE	23	16
BARBER HECTOR	102	
BARBER NARA	10	
BARBER PERSEUS	88	
BARBER TAMPA	3	32
BARBER TEXAS	1	1
BARBER TOBA	1	
BARRYDALE	43	
BAY BRIDGE	56	
BAYANI	2	28
BAYANON	47	159
BCR KING	91	
BEER SHEVA	6	
BENSON FORD		4
BERNINA	10	113
BHARATENDU	3	
BHAVABHUTI	11	
BIBI	42	
BISLIG BAY	97	
BLUE HAWK	23	
BOGASARI DUA	2	
BRILLIANT ACE	12	
BROOKLYN	54	228
BROOKLYN BRIDGE	36	93
BROOKS RANGE	27	69
BUNGA KENANGA	5	
BUNGA KESIDANG	35	66
BUNGA MELAWIS	2	
BURNS HARBOR		29
C.MEHMET	38	55
CALIFORNIA RAINBOW	20	
CALYPSO	2	
CANADIAN RAINBOW	7	194
CAPE BYRON	41	
CAPE DUCATO	18	42
CAPE HATTERAS	116	
CAPE ROGER	20	
CAPE YORK	88	
CARIBE 1	13	56
CARLA A. HILLS		186
CARMEN	1	
CASON J. CALLAWAY	17	30
CELEBRATION	16	161
CGM LORRAINE	19	

Ship Name	radio	mail
CHACO	6	12
CHALLENGER	38	82
CHARLES PIGOTT		7
CHARLOTTE LYKES	91	81
CHELSEA	8	97
CHEMICAL PIONEER	27	103
CHESAPEAKE BAY	31	171
CHESAPEAKE TRADER	83	125
CHESNUT HILL	13	50
CHEVRON ANTWERP	17	135
CHEVRON ARIZONA	7	105
CHEVRON BURNABY	47	234
CHEVRON CALIFORNIA	82	123
CHEVRON COLORADO	19	45
CHEVRON COPENHAGEN	19	27
CHEVRON EDINBURGH	27	118
CHEVRON EQUATOR	19	140
CHEVRON FELUY	23	73
CHEVRON LONDON		134
CHEVRON LOUISIANA	19	71
CHEVRON METEOR	30	240
CHEVRON MISSISSIPPI	113	188
CHEVRON NAGASAKI	13	195
CHEVRON OREGON	70	101
CHEVRON PACIFIC	58	151
CHEVRON STAR	5	179
CHEVRON SUN		221
CHEVRON WASHINGTON	19	101
CHICKASAW	12	
CHIKUMAGAWA MARU	11	
CHRISTINA	81	
CITADEL HILL	62	
CITY OF MIDLAND	15	112
CLARENCE	69	
CLEMENT	111	
CLEMENTINA	14	
CLIFFORD MAERSK	7	57
CO-OP EXPRESS I	25	
CO-OP EXPRESS II	17	
COAST RANGE	9	38
COLIMA	12	
COLUMBUS AMERICA	223	
COLUMBUS AUSTRALIA	70	
COLUMBUS CALIFORNIA	70	
COLUMBUS LOUISANA	74	
COLUMBUS NEW ZEALAND	25	
COLUMBUS VICTORIA	90	
COLUMBUS VIRGINIA	81	
COLUMBUS WELLINGTON	38	
CONCERT EXPRESS	40	
CONTENDER ARGENT	21	
CONTINENTAL TRADER	10	
CORNUCOPIA	47	205
CORONADO	45	68
COUNTESS SKY	19	20
CPL. LOUIS J. HAUGE JR	20	44
CRUSADER VENTURE	55	
CURRENT	34	
CYGNUS	65	64
D.L. BOWER		170
DA MOSTO	21	
DALAMAN	7	14
DAMIOS DE GOIS	33	
DANAH	67	48
DAWN	75	88
DELAWARE BAY	36	115
DELAWARE TRADER	46	89
DEVELOPER	54	221
DIANA	7	21
DILIGENCE TRADER		126

Ship Name	radio	mail
DOCK EXPRESS TEXAS		85
DREDGE WHEELER	4	16
DUBHE	73	147
DUSSELDORF EXPRESS	45	
DYVI KATTEGAT	3	80
E.R. BRUSSEL	26	
EASTERN FRIENDSHIP	31	159
EASTERN GLORY	16	
EASTERN ROYAL	44	18
EASTERN VENTURE	25	107
EASTERN WISEMAN	12	
EDGAR M. QUEENY	22	43
EDWIN H. GOTT		33
ELBE MARU	114	
ELGAREN	97	
EMPIRE STATE	1	
ENDEAVOR	4	17
EVER GAINING	16	
EVER GATHER	15	66
EVER GENERAL	5	
EVER GENIUS	1	8
EVER GENTLE	8	28
EVER GENTRY	10	
EVER GIANT		23
EVER GIFTED	23	29
EVER GIVEN	5	
EVER GLEAMY	16	13
EVER GLOBE	6	
EVER GLORY	24	41
EVER GOLDEN	5	24
EVER GOVERN	20	50
EVER GRACE	12	12
EVER GROUP	12	
EVER GROWTH	8	41
EVER GUARD	7	23
EVER GUIDE	11	
EVER LEVEL	19	103
EVER LINKING	2	9
EVER LIVING	2	
EVER LOADING	16	43
EVER LYRIC	64	97
EVER SHINE	4	
EVER SPRING	13	
EVER SUMMIT	6	39
EVER SUPERB	6	
EVER VALOR	31	72
EVER VALUE	26	77
EVER VITAL	34	92
EXPORT CHAMPION	37	65
EXPORT FREEDOM	1	
EXPORT PATRIOT	39	96
EXXON BALTIMORE		1
EXXON BATON ROUGE	16	22
EXXON BAYTOWN	12	42
EXXON BENICIA	39	59
EXXON BOSTON	7	87
EXXON HOUSTON	46	102
EXXON LEXINGTON	2	
EXXON LONG BEACH	19	47
EXXON NEW ORLEANS	22	27
EXXON NORTH SLOPE	3	5
EXXON PHILADELPHIA	40	84
EXXON PRINCETON	4	3
EXXON SAN FRANCISCO	7	15
EXXON VALDEZ	22	29
EXXON YORKTOWN	1	8
FAIRBANKS		17
FALCON LEADER	8	
FALSTAFF	11	
FALSTRIA	85	184
FARLAND	98	
FARNELLA	17	
FERNAO LOPES	7	
FERNCROFT	48	94
FETISH		192
FIRST LT JACK LUMMUS	17	
FLORIDA RAINBOW	9	69
FORTALEZA	75	57

Ship Name	radio	mail
FRANCIS SINCERE NO. 6	46	59
FRED R WHITE JR		1
FREDERICKSBURG	44	127
FREMO SIRIUS		24
FROTASIRIUS	6	
GALVESTON BAY	5	
GEAR GARLAND	40	86
GEMINI	72	133
GEN. A. S. CEBESOY	6	
GENERAL M.BELGRANDO	2	
GENERAL ROXAS	47	92
GENEVIEVE LYKES	3	
GEORGE A. SLOAN	3	3
GEORGE H. WEYERHAEUSER	21	68
GEORGE WASHINGTON BRID	178	55
GERONIMO		14
GLACIER BAY	27	95
GLOBAL FRONTIER	68	122
GLOBAL PIONEER	36	14
GLORIA	8	
GLORIOUS SPICA	105	
GLORY FIELD	40	80
GLORY SPIRIT	34	
GOLAR PETROSUN	24	45
GOLDEN APO	38	31
GOLDEN BEAR	21	
GOLDEN BLISS	14	73
GOLDEN GATE	2	28
GOLDEN GATE BRIDGE	158	54
GOLDEN HAWK	66	157
GRACE ISLAND	1	
GRAIGLAS	118	
GREAT LAND	136	136
GREEN ANGELES	8	28
GREEN BAY	53	192
GREEN HARBOUR	40	
GREEN ISLAND	40	115
GREEN LAKE	31	139
GREEN MASTER	52	81
GREEN MAYA	45	54
GREEN RAINIER	4	
GREEN SAIKAI	17	
GREEN STAR	81	24
GREEN VALLEY	22	71
GREEN WAVE	28	94
GREEN WOOD	10	17
GUAICURI	26	
GUANAJUATO	29	92
GUARDSMAN		117
GULF IDEAL	38	84
GYPSUM BARON	117	
GYPSUM COUNTESS	26	
GYPSUM KING	106	
HAI JUNG	21	
HAKUSAN	87	
HANEI PEARL	6	
HANJIN BUSAN	2	11
HANJIN CHEJU	7	16
HANJIN HONG KONG	26	37
HANJIN KEELUNG	4	41
HANJIN KOBE	10	14
HANJIN KWANGYANG	1	25
HANJIN LONG BEACH	7	
HANJIN POHANG	26	15
HANJIN SAVANNAH	26	
HANJIN SEOUL	8	8
HANJIN YOKOHAMA	11	12
HANSA BERGEN	17	70
HARMAC DAWN	73	
HASSAN MERCHANT	95	118
HAUL TRAVELLER	4	18
HAWAIIAN RAINBOW	18	40
HAWTHORN HILL	7	32
HEERENGRASHT	71	
HEIDE	93	
HENRY HUDSON BRIDGE.	170	
HERMENIA	3	46
HIRA MARU	81	76

Ship Name	radio	mail
HIYOSHI MARU	57	
HOEGH CAIRN	16	39
HOEGH CLIPPER	13	29
HOEGH DRAKE	4	
HOEGH DUKE	78	
HOEGH DYKE	13	52
HOEGH MINERVA	1	
HOHSING BREEZE	27	90
HOJIN MARU	17	
HOLIDAY	29	154
HOLSTEN TRADER	24	30
HOMERIC	3	
HONOLULU	14	
HRELJIN	15	
HUAL ROLITA	6	61
HUMBER ARM	27	85
HYUGA MARU	80	
HYUNDAI #101	12	13
HYUNDAI #103		44
HYUNDAI #108	65	161
HYUNDAI #203	5	17
HYUNDAI #205		18
HYUNDAI CHALLENGER	84	105
HYUNDAI EXPLORER	11	55
HYUNDAI INNOVATOR		5
HYUNDAI NO. 109		16
HYUNDAI PIONEER		69
IBIS ARROW	87	82
IMPERIAL	1	10
INCOTRANS PACIFIC	1	
INDONESIA VICTORY	14	
INGER	25	
ISLAND PRINCESS	59	
ITALICA	9	75
ITAPE	20	
J.T.HIGGINS		10
JADRAN EXPRESS	11	
JALISCO	36	132
JAMES LYKES	19	
JAPAN ALLIANCE	82	96
JAPAN APOLLO	155	115
JAPAN STORK	13	32
JEAN LYKES	36	71
JEBEL ALI	14	
JO BIRK	72	
JO CLIPPER	100	
JO CYPRESS	76	
JO LONN	110	
JO OAK	112	
JOHN G. MUNSON	7	22
JOHN LYKES		2
JOVIAN LILY	55	148
JUBILEE		20
JULIUS HAMMER		156
KAHAROA	46	
KALAYAAN	98	
KALIDAS	39	24
KASINA	46	48
KAUAI	46	199
KEE LUNG	16	
KEISHO MARU	52	63
KENAI	24	
KENIA		31
KENNETH E. HILL	4	38
KENNETH T. DERR	10	56
KENT	51	84
KEYSTONE CANYON	33	122
KEYSTONER	22	150
KITTANNING	4	13
KOFUKU MARU	16	69
KOLN EXPRESS	62	
KOREAN WONIS JIN	7	4
KOREAN WONIS ONE	44	32
KOREAN WONIS SEVEN	38	51
KOREAN WONIS SUN	11	15
KRPAN	1	
KUMANDER	10	13
KUROBE	86	

Ship Name	radio	mail
KUSAN	15	23
LA PAMPA	19	
LANCASHIRE	1	
LARS MAERSK	20	51
LAURA MAERSK	26	69
LAWRENCE A. GIANELLA	28	58
LEDA MAERSK	26	87
LEGION	15	29
LEISE MAERSK	18	84
LERMA	131	
LESLIE LYKES	6	40
LETITIA LYKES	24	31
LEWIS WILSON FOY		16
LEXA MAERSK	35	99
LIBERTADOR GRAL SAN MA	1	
LICA MAERSK	79	106
LILLOOET	60	58
LING LEO	3	182
LIONS GATE BRIDGE	31	153
LLOTD ITAJAI	92	
LLOYD SAO PAULO	63	
LLOYD SERGIPA	15	82
LLOYD VITORIA	62	51
LNG TAURUS	51	159
LONG BEACH	42	81
LONG LINES	20	
LOTUS ACE	71	
LOUIS MAERSK	39	69
LOUISE LYKES	48	144
LOUISIANA BRIMSTONE	35	133
LT. ODYSSEY	21	
LURLINE	49	207
LUZON	19	181
M. P. GRACE	92	
M/V MARINE RELIANCE	51	115
MACKINAC BRIDGE	148	
MADAME BUTTERFLY	29	
MADANG	5	
MAERSK TACOMA	65	105
MAERSK TOKYO	59	
MAERSK WAVE		39
MAERSK WIND	76	191
MAJ SANDVED	44	15
MAJ STEPHEN W PLESS MP	27	44
MALLORY LYKES	37	126
MANHATTAN BRIDGE	61	
MANUKAI	55	184
MANULANI	26	213
MARATHA MARINER	19	30
MARATHA MELODY	7	
MARATHA SHOGUN	11	
MARGARITA	81	253
MARIA TOPIC	18	60
MARIF	18	39
MARITIME NOBLE	135	
MARJORIE LYKES	18	43
MARLIN	12	74
MASON LYKES	28	110
MATSONIA	46	204
MAUI	55	178
MC KINNEY MAERSK	19	
MED TRANSPORTER	4	
MEDALLION	59	147
MEDUSA CHALLENGER		23
MELBOURNE HIGHWAY	1	30
MELVILLE	14	60
MENINA BARBARA	38	101
MERAK EIGHTY	15	
MERCANDIAN CONTINENT	1	64
MERIDA	31	193
MICHIGAN HIGHWAY	72	
MICRONESIAN COMMERCE	41	51
MICRONESIAN INDEPENDEN	113	39
MILTA	22	128
MING GLORY	7	21
MING LONGEVITY		1
MING MOON	21	25

Ship Name	radio	mail
MING OCEAN	2	38
MING PEACE		28
MING PLEASURE	4	
MING PROMOTION	16	19
MING PROPITIOUS	8	
MING STAR	1	9
MING SUN	3	8
MOANA PACIFIC	216	275
MOANA WAVE	18	
MOBIL ARCTIC	47	148
MOBIL MERIDIAN	143	208
MOBILE BAY	2	
MOKU PAHU	49	110
MORMACSKY	10	30
MORMACSTAR	37	162
MORMACSUN	78	177
MOSEL EXPRESS	140	
MOUNT FUJI	21	
MT. ELIANE	22	44
NACIONAL SANTOS	9	
NADA II		42
NANCY LYKES	9	
NATIONAL DIGNITY	35	156
NATIONAL HONOR	14	72
NATIONAL PRIDE	15	134
NAVIGATOR		161
NAVIOS ENTERPRISE	6	
NECHES	12	10
NEDLLOYD ELBE	84	
NEDLLOYD KATWIJK	142	
NEDLLOYD KEMBLA	59	
NEDLLOYD KIMBERLEY	1	
NEDLLOYD KINGSTON	93	
NEDLLOYD KYOTO	116	
NEDLLOYD ROCHESTER	114	
NEDLLOYD ROSARIO	105	
NEDLLOYD ROTTERDAM	81	
NEDLLOYD ROUEN	124	
NEPTUNE ACE	29	
NEPTUNE AMBER	60	177
NEPTUNE CORAL	88	231
NEPTUNE DIAMOND	127	
NEPTUNE GARNET	57	
NEPTUNE IVORY	96	
NEPTUNE JADE	86	
NEPTUNE KIKU	3	
NEPTUNE PEARL	43	55
NEPTUNE TOURMALINE	16	
NEW HORIZON		36
NEW INDEPENDENCE	49	128
NEW JERSEY MARU	84	
NEW NOBLE	6	
NEW ORION		109
NEW SOVEREIGN	22	
NEW TURQUOISE	32	38
NEW YORK MARU	91	
NISSAN LAUREL	5	
NOAA DAVID STARR JORDA	63	125
NOAA MALCOLM BALDRIDGE	14	16
NOAA SHIP ALBATROSS IV	78	163
NOAA SHIP CHAPMAN	339	201
NOAA SHIP DAVIDSON		14
NOAA SHIP DELAWARE II	79	83
NOAA SHIP DISCOVERER O	127	111
NOAA SHIP FERREL	88	114
NOAA SHIP HECK 591		38
NOAA SHIP JOHN N COBB	35	
NOAA SHIP MILLER FREEM	259	363
NOAA SHIP MT MITCHEL	301	419
NOAA SHIP OCEANOGRAPHE	55	
NOAA SHIP OREGON II	248	
NOAA SHIP RUDE 590	1	46
NOAA SHIP SURVEYOR	63	
NOAA SHIP T. CROMWELL	326	419
NOAA SHIP WHITING	143	219
NORDHVAL	65	
NORWAY	6	45

Ship Name	radio	mail
NOSAC EXPRESS	48	143
NOSAC SEL	59	91
NOSAC SKAUKAR	54	137
NOSAC TAI SHAN	12	32
NOSAC TAKARA	46	97
NOSAC TAKAYAMA	87	258
NOSAC TRIGGER	51	217
NOSIRA SHARON	54	
NURNBERG EXPRESS	69	
OAKLAND	138	92
OBERON	7	21
OCEAN BRIDGE	3	
OCEAN CHEER	10	
OCEAN COMMANDER #1	28	17
OCEAN LEGEND	7	
OCEAN LUCKY	21	110
OCEAN STEELHEAD	19	65
OLEANDER	104	118
OLGA TOPIC	8	102
OMI CHAMPION	13	57
ORAGONJA	2	62
ORANGE BLOSSOM	51	100
ORANGE STAR		27
ORCHID	29	48
ORCHID #2	29	67
OREGON RAINBOW	13	97
ORIENTAL DIPLOMAT	31	
ORIENTAL EDUCATOR	142	214
ORIENTAL EXECUTIVE	48	249
ORIENTAL EXPLORER	52	159
ORIENTAL FAIR	60	123
ORIENTAL FAITH	29	84
ORIENTAL FORTUNE	19	15
ORIENTAL FREEDOM	120	
ORIENTAL FRIENDSHIP	57	
ORIENTAL KNIGHT	6	
ORIENTAL MINISTER	60	
ORIENTAL PATRIOT	27	164
ORIENTAL PHOENIX		258
ORIENTAL SOVEREIGN	27	
ORIENTAL TAIO	7	
ORION HIGHWAY	34	
ORLY	8	
OTELLO	41	87
OVERSEAS ALICE	12	21
OVERSEAS CHICAGO	2	43
OVERSEAS HARRIET	47	121
OVERSEAS JOYCE	45	82
OVERSEAS JUNEAU	37	87
OVERSEAS MARILYN	6	38
OVERSEAS OHIO	7	107
OVERSEAS VIVIAN	46	42
OVERSEAS WASHINGTON	72	159
PACDUCHESS	26	
PACEMPEROR	24	27
PACGLORY	23	
PACIFIC ANGEL	42	42
PACIFIC ARROW	135	104
PACIFIC DAWN	45	
PACIFIC ENTREPRENEUR	19	22
PACIFIC HIGHWAY	49	34
PACIFIC PRINCESS	80	
PACIFIC PROSPERITY	6	16
PACIFIC RAINBOW	19	83
PACIFIC VENTURE	9	
PACIFIC VICTORY	22	42
PACIFIC WING	47	
PACKING	2	
PACMAJESTY	31	
PACMERCHANT	26	20
PACMONARCH	6	
PACNOBLE	2	
PACPRINCE	2	
PACPRINCESS	33	68
PALM ACE	1	
PANAMA	6	222
PATRIOT	16	

Ship Name	radio	mail
PAUL BUCK	11	39
PAUL H. TOWNSEND		5
PAWNEE	18	58
PECOS	16	37
PEGGY DOW	140	
PENNSYLANIA RAINBOW	20	
PENNSYLVANIA TRADER	8	68
PETER W.ANDERSON		38
PETERSFIELD	78	
PFC EUGENE A. OBREGON	15	24
PFC JAMES ANDERSON JR	31	113
PFC WILLIAM B. BAUGH	51	60
PHAROS	86	
PHILIP R. CLARKE	16	20
PHILIPPINE VICTORY	29	
PHOENIX DIAMOND	5	70
PILAR	4	131
POLAR ALASKA	17	208
POLYNESIA	114	162
PONCE	33	85
POQUITA MAMI	20	63
POTOMAC TRADER	23	53
PRESIDENT ARTHUR	86	252
PRESIDENT BUCHANAN	81	201
PRESIDENT CLEVELAND	32	36
PRESIDENT EISENHOWER	123	47
PRESIDENT F. ROOSEVELT	92	211
PRESIDENT GARFIELD	80	261
PRESIDENT GRANT	46	87
PRESIDENT HARDING	63	249
PRESIDENT HARRISON	61	218
PRESIDENT HOOVER	9	112
PRESIDENT JEFFERSON	43	128
PRESIDENT JOHNSON	54	161
PRESIDENT KENNEDY	23	23
PRESIDENT LINCOLN	121	189
PRESIDENT MADISON	60	153
PRESIDENT MONROE	86	175
PRESIDENT PIERCE	75	134
PRESIDENT TAYLOR	30	66
PRESIDENT TYLER	97	263
PRESIDENT VAN BUREN	31	43
PRESIDENT WASHINGTON	110	206
PRESQUE ISLE		5
PRIDE OF TEXAS	10	6
PRIMORJE	30	
PRINCE OF TOKYO	74	253
PRINCE WILLIAM SOUND	31	135
PRINCESS DIAN	44	136
PROSPERIDAD	57	248
PUERTO RICO	46	201
PUNTA BRAVA	6	
PUNTA MALVINAS	2	
PVT HARRY FISHER	37	65
QUEEN ELIZABETH 2	31	
QUEEN OPAL	42	20
RAINBOW BRIDGE	92	47
RAINBOW HOPE	149	288
RANGER	39	56
RED ARROW	15	
REGENT	7	27
REGINA MAERSK	16	101
RICHARD G MATTIESEN	140	
RIMBA SEPETIR	22	
RIO ESQUEL	53	47
RIO FRIO	15	
RIO GRANDE	6	
RIO LIMAY	30	34
ROBERT CONRAD	111	25
ROBERT E. LEE	20	32
RODIN	49	
ROGER BLOUGH		12
ROGER R. SIMONS		3
ROSARIO DEL MAR	9	22
ROSINA TOPIC	35	
ROSTAND	94	
ROTTERDAM	86	

Ship Name	radio	mail
ROVER	24	127
ROYAL PRINCESS	54	
ROYAL VIKING SEA	46	38
ROYAL VIKING SKY	63	
RUTH LYKES	27	
RV CALANUS		6
S.A. MORGENSTER	1	
S.T. CRAPO		3
SAINT LAURENT	24	
SAM HOUSTON	11	30
SAMOAN REEFER	14	
SAMRAT ASHOK	8	
SAMU	3	198
SAN JUAN	30	114
SAN MARTIN I	67	
SAN MATEO VICTORY	4	39
SANKO CORAL		12
SANKO DAFFODIL	1	
SANKO DIGNITY	6	
SANKO HAWK	17	
SANKO LAPIS	58	44
SANKO PEACE	33	
SANKO PEACOCK	16	
SANKO PELARGONIUM	1	5
SANKO ROBIN	18	
SANKO STORK	8	
SANSINENA II	22	101
SANTA ADELA	46	140
SANTA CRUZ II	37	
SANTA JUANA	78	220
SATURN DIAMOND	15	181
SAUDI DIRIYAH	29	
SAUDI HOFUF	15	
SAUDI MAKKAH	33	
SAUDI RIYADH	48	
SAUDI TABUK	21	
SAVANNAH	99	
SCANDINAVIAN HIGHWAY	68	
SEA BELLS	21	109
SEA DIAMOND	62	138
SEA FAN	41	155
SEA FORTUNE	39	76
SEA FOX	12	82
SEA JADE	37	130
SEA LANTERN	58	179
SEA LIGHT	24	144
SEA LION	132	198
SEA TRANSPORTER	65	
SEA WOLF	27	207
SEALAND ADVENTURER	45	169
SEALAND ANCHORAGE	25	81
SEALAND CONSUMER	33	177
SEALAND DEFENDER	35	188
SEALAND ECONOMY	28	185
SEALAND ENDURANCE	29	153
SEALAND ENTERPRISE	58	221
SEALAND EXPLORER	75	115
SEALAND EXPRESS	44	156
SEALAND FREEDOM	26	82
SEALAND HAWAII	42	180
SEALAND INDEPENDENCE	60	176
SEALAND INNOVATOR	58	177
SEALAND KODIAK	11	25
SEALAND LEADER	28	186
SEALAND LIBERATOR	43	141
SEALAND MARINER	53	137
SEALAND MARKETER	21	69
SEALAND NAVIGATOR	53	200
SEALAND PACER	25	44
SEALAND PACIFIC	49	196
SEALAND PATRIOT	45	149
SEALAND PIONEER	31	96
SEALAND PRODUCER	31	135
SEALAND TRADER	113	258
SEALAND VENTURE	42	212
SEALAND VOYAGER	106	170
SEAWARD BAY	27	37

Ship Name	radio	mail
SEDCO/BP 471	49	203
SENATOR		36
SEVEN OCEAN	28	43
SGT WILLIAM A BUTTON		31
SGT. METEJ KOCAK	8	21
SHELDON LYKES	69	120
SHELLY BAY	14	19
SHIN BEISHU MARU	38	
SHINKASHU MARU	61	
SIERRA MADRE	7	
SILVER CLIPPER	25	
SILVER STAR	1	
SILVER VICTORY		46
SINGA ACE	20	130
SINGAPORE VICTORY	1	160
SIOUX TATE	16	
SKANDERBURG	35	61
SKAUBORO	59	176
SKAUGRAN	38	130
SKEENA	65	
SKRIM	119	
SOLON TURMAN	3	12
SONBAI	26	
SONORA		93
SOPHIA	107	
SOREN TOUBRO	12	73
SOUTHLAND STAR	107	
SOUTHWARD	125	127
SPIRIT OF TEXAS	10	
SPRING BEAR	100	
SPRING BIRD	5	7
SPRING DELIGHT	10	
SPRING VEGA	11	
STAR EAGLE	51	157
STAR ESPERANZA	62	209
STAR GEIRANGER	15	72
STAR GRAN	13	80
STAR HONGKONG	74	
STAR MIRANDA	14	43
STAR OF TEXAS	78	
STELLA LYKES	2	108
STEWART J. CORT		13
STONEWALL JACKSON	11	
STRATHCONON	93	
STREAM BALABAC	20	112
STREAM RUDDER	1	
STRIDER ISIS	4	
STUTTGART EXPRESS	43	
SUE LYKES	23	
SUGAR ISLANDER	12	
SUN PACIFIC #2	3	27
SUN PRINCESS	145	
SUN VIKING	2	
SUNBELT DIXIE	98	223
SUNNY SUPERIOR		88
SUNORA	54	41
SUSAK	13	
SUZUKASAN MARU	102	
TABASCO	50	124
TAI CORN	14	35
TARGET	77	158
TEXACO FLORIDA	22	41
TEXACO GEORGIA	3	55
TEXACO MASSACHUSETTS	11	12
TFL FREEDOM		96
TFL INDEPENDENCE	2	
TFL LIBERTY	3	84
THOMAS WASHINGTON	102	275
THOMPSON LYKES	22	34
THOMPSON PASS		77
TOHBEI MARU	61	46
TOKYO MARU	52	
TOKYO RAINBOW	29	37
TONCI TOPIC	13	151
TONIC VENTURE	1	37
TONSONIA	66	194
TOWER BRIDGE	59	

Ship Name	radio	mail
TRAVE ORE	9	35
TROPIC SUN	27	86
TROPICAL BEAUTY	20	41
TROPICALE	30	115
TULSIDAS	36	
TUNISIAN REEFER	4	41
ULTRAMAR	18	87
ULTRASEA	17	95
UNITED HOPE	22	
UNITED SPIRIT	33	17
UNIVERSE	9	
USCGC ACACIA (WLB406)		3
USCGC ACTIVE WMEC 618	1	
USCGC ALERT (WMEC 630)	15	31
USCGC BASSWOOD (WLB 38	2	
USCGC BEAR (WEMC 901)	3	
USCGC BISCAYNE BAY	12	56
USCGC BLACKHAW (WLB 39	2	
USCGC BOUTWELL WHEC 71	67	69
USCGC BUTTONWOOD WLB 3	26	
USCGC CHEROKEE WMEC 16	9	39
USCGC CHILULA (WMEC 15	5	
USCGC CITRUS (WMEC 300	16	
USCGC CLOVER (WMEC 292	2	
USCGC COURAGEOUS	1	
USCGC DEPENDABLE	12	
USCGC EAGLE (WIX 327)	117	157
USCGC ESCANABA	8	
USCGC EVERGREEN WMEC 2	11	
USCGC FIREBUSH WLB 393	24	29
USCGC HARRIET LANE	11	26
USCGC IRONWOOD (WLB 29	9	
USCGC KATMAI BAY	3	17
USCGC LIPAN (WMEC 85)	1	
USCGC MACKINAW	98	505
USCGC MESQUITE (WLB 30		25
USCGC MIDGETT (WHEC 72	1	
USCGC MORGENTHAU	19	16
USCGC NEAH BAY	1	
USCGC NORTHLAND WMEC 9	30	
USCGC NORTHWIND WAGB 2	9	11
USCGC PLANETREE	6	
USCGC POLAR SEA WAGB 1	124	177
USCGC POLAR STAR WAGB	86	136
USCGC RESOLUTE WMEC 62	11	
USCGC RUSH (WHEC 723)		43
USCGC SALVIA (WLB 400)	4	
USCGC SASSAFRAS	17	36
USCGC SEDGE (WLB 402)	17	
USCGC STORIS (WMEC 38)	2	44
USCGC SUNDEW (WLB 404)	1	41
USCGC SWEETBRIER WLB 4	10	23
USCGC TAMAROA (WMEC 16	43	
USCGC VALIANT (WMEC 62	14	
USCGC VIGILANT WMEC 61	20	60
USCGC VIGOROUS WMEC 62	1	
USCGC WOODRUSH (WLB 40	30	
USCGC YOCONA (WMEC 168	88	164
USNS ANTARES	2	
USNS APACHE (T-ATF 172	8	
USNS BARTLETT(T-AGOR 1	33	110
USNS BELLATRIX	20	
USNS CHAUVENET	37	54
USNS GUS W. DARNELL	24	
USNS HENRY J. KAISER		28
USNS JOHN LENTHAL		103
USNS KANE TAGS 27	6	
USNS MERCURY	52	131
USNS MISSISSINEWA		141

Ship Name	radio	mail
USNS MOHAWK (T-ATF 170	16	23
USNS NARRAGANSETT	5	16
USNS NAVAJO	83	263
USNS NEOSHO (T-AO 143)		53
USNS PASSUMPSIC TAO 10		96
USNS PAWCATUCK TAO-108		8
USNS POWHATAN TATF 166	23	64
USNS REDSTONE		110
USNS REGULUS	29	
USNS SATURN T-AFS-10		102
USNS SEALIFT ANTARCTIC	23	63
USNS SEALIFT ARABIAN S	44	141
USNS SEALIFT ARCTIC	17	151
USNS SEALIFT ATLANTIC	19	94
USNS SEALIFT CHINA SEA	2	9
USNS SEALIFT MED	36	80
USNS SEALIFT PACIFIC	21	60
USNS SILAS BENT T-AGS	11	
USNS SPICA (T-AFS 9)		16
USNS STALWART T-AGOS-1		23
USNS TRUCKEE (T-AO 147		19
USNS VANGUARD TAG 194	63	188
USNS WACCAMAW(TAO-109)		44
VALLEY FORGE	35	126
VERRAZANO BRIDGE	144	
VIRGO	15	78
VISHVA PANKAJ	1	
VISHVA PAROG	4	
VISHVA PRAFULLA	4	81
VISHVA SIDDHI	5	
WALCHAND	7	
WASHINGTON HIGHWAY	193	46
WASHINGTON RAINBOW #2	21	65
WECOMA		198
WELLINGTON STAR	110	
WESER EXPRESS	19	
WESTERN PROGRESS		62
WESTIN WON	10	
WESTOCEAN	250	
WESTWARD		12
WESTWARD VENTURE	82	117
WESTWOOD ANNETTE	3	94
WESTWOOD BELINDA		20
WESTWOOD JAGO	96	57
WESTWOOD MARIANNE	28	119
WESTWOOD MERCHANT		45
WESTWOOD MERIT	26	85
WILFRED SYKES	11	48
WILLIAM J. DELANCEY		5
WILLOWBANK	78	
WINTER MOON	44	
WINTER STAR	34	21
WINTER SUN	43	
WORLD WING #2	99	
YAMAHIME MARU	18	
YAMASHIN MARU	118	85
YAMATAKA MARU	46	
YOHFU		65

Ship Name	radio	mail
YOUNG SCOPE	65	
YOUNG SKIPPER	25	18
YOUNG SOLDIER	33	14
YOUNG SPORTSMAN	15	53
YOUNG SPROUT	81	126
YOUNG SWIFT		12
YS ARGOSY	31	62
ZAPATA ARCTIC	142	
ZAPATA COURIER	20	8
ZEELANDIA	32	
ZIM GENOVA	27	
ZIM HAIFA	18	
ZIM HONGKONG	42	
ZIM HOUSTON	4	
ZIM IBERIA	47	
ZIM KEELUNG	29	
ZIM MARSEILLES	20	
ZIM MIAMI	19	
ZIM NEW YORK	43	
ZIM SAVANNAH	34	
ZIM TOKYO	30	
ZOELLA LYKES	12	45
3EWQ3	2	21
ZSZS	1	
ZSZW	103	
ZTFT	104	
ZTMI	1	
ZTMR	97	
ZTSG	119	
ZTUG	1	
ZTVR	1	
ZUAB	16	
ZUAE	1	
ZUB	1	
ZUBG	1	
ZUBR	120	
ZUCU	1	
ZUFRE	1	
ZUH	1	
ZUHG	1	
ZUJBX	1	
ZUJNJ	1	
ZUM	1	
ZUSE	1	
ZUV	1	
ZUZR	1	
ZVCB	1	
ZVIO	1	
ZVKC	1	
ZVRNA	1	
ZVRP	1	
ZVRR	1	
ZVSBW3	1	
ZVVK	1	
ZWEL	1	
ZWN	1	
ZWQQE	1	
ZWS	1	
ZWY	2	
ZXTZ	1	
ZY5BO	1	
ZYHX	1	
ZYJN	2	
ZYJNN	1	
ZYRPRQ	1	
ZYY	4	
ZYZ	1	
ZZ	2	
ZZD	1	

SUMMARY: GRAND TOTAL VIA RADIO 38641

GRAND TOTAL VIA MAIL 59599

TOTAL UNIQUE OBS 79915

TOTAL DUPLICATES 18325 (22.9%)

UNIQUE RADIO OBS.20316 (25.4%)

UNIQUE MAIL OBS. 41274 (51.6%)

Top Ships

Radio	Mail
Westocean	Atigun Pass
NOAA Ship Chapman	USCGC Mackinaw

Bathy-Tesac Data Received at NMC

January, February and March 1988

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
AMMC	183	183	0	MELBOURNE
BIRK	3	3	0	REYKJAVIK
CWHF	324	309	15	HALIFAX MET.
EDZW	470	327	143	OFFENBACH
EGRR	165	165	0	BRACKNELL
ESWI	133	120	13	STOCKHOLM
ETRW	10	0	10	WARNEMUNDE
FAPR	3	3	0	PRETORIA
KNWC	2026	2026	0	MONTEREY, CA.
KSAN	40	40	0	SAN DIEGO, CA.
KWBC	2632	2622	10	WASHINGTON, D.C.
LFPW	264	264	0	PARIS
NTAA	32	32	0	TAHITI
RJTD	958	958	0	TOKYO
RUHB	659	30	629	KHABAROVSK
RUML	51	51	0	***
RUMS	1455	1030	425	MOSCOW
SABM	25	25	0	BUENOS AIRES
A8VI	27	27	0	PACDUCHESS
A8YI	2	2	0	PACBARON
CBAK	15	15	0	ANAKENA
CGDV	131	131	0	W. TEMPLEMAN
CGWF	1	1	0	***
CG2683	23	23	0	ALFRED NEEDLER
CG2959	48	48	0	LEONARD J. COWLEY
CSBL	17	17	0	DAMIAO DE GOIS
C2965	2	2	0	RICKER
C6CV9	19	19	0	LILLOOET
C7C	164	0	164	OCEAN STATION CHARLIE
C7L	121	121	0	OCEAN STATION LIMA
DBFJ	22	22	0	FRITHJOF
DBFP	50	50	0	WALTHER HERWIG
DCH	34	4	30	ELBE I
DCL	65	0	65	FEHMARNBELT-FEUERSCHIFF
DESI	86	38	48	VALDIVIA
DGFR	57	57	0	COLUMBUS CALIFORNIA
DGLM	46	46	0	MONTE ROSA
DGSR	5	5	0	COLUMBUS CANADA
DGVK	59	59	0	COLUMBUS VICTORIA
DGZV	108	108	0	COLUMBUS VIRGINIA
DHCW	23	23	0	COLUMBUS WELLINGTON
DHJW	36	36	0	ACT 9
DHOU	96	96	0	PURITAN
DILM	58	58	0	ACT 10
DLEZ	19	19	0	YANKEE CLIPPER
DRHB	3	3	0	***
DZVK	1	1	0	T. REY
D5ND	42	42	0	SAINT LUCIA
D5NE	52	52	0	MT CABRITE
D5NZ	86	86	0	POLYNESIA
ELDM8	65	65	0	SEAL ISLAND
ELDW8	55	55	0	SKRIM
ELED8	14	14	0	PACPRINCESS
EREA	193	141	52	MUSSON
EREB	164	50	114	VOLNA
EREC	73	0	73	PRYLYV
EREH	77	0	77	PRIBOI
EREI	154	13	141	OKEAN
ERES	151	103	48	VICTOR BUGAEN
ERET	68	67	1	GEORGE OUSHAKOV
EREU	150	150	0	ERNST KRENKEL
ESGG	94	8	86	FROLOV VYACHESLAV
ESGU	15	0	15	PERCY 3
FBAC	1	1	0	***
FNBA	95	95	0	CRYOS
FNBE	2	2	0	***
FNBF	36	36	0	ROSTAND
FNCW	46	46	0	ROUSSEAU
FNGS	86	86	0	LAFAYETTE
FNMZ	36	36	0	CORIOLIS
FNOM	6	6	0	ANGO
FNPA	9	9	0	RONSARD
FNQB	14	14	0	ILE MARURICE
FNQC	59	59	0	VILLE DE ROUEN
FNQM	8	8	0	VILLE DE BORDEAUX
FNXE	69	69	0	RODIN
GACA	29	29	0	***
GOVL	11	11	0	ACT 4
GPHH	20	20	0	FARNELLA
GXRH	16	16	0	***
GXYY	8	8	0	AUSTRALIA STAR
GYRW	18	18	0	ENCOUNTER BAY
GZKA	59	59	0	ACT 3
HCGT	1	1	0	BUCCANEER
HPAN	52	52	0	MICRONESIAN COMMERCE
HPEW	17	17	0	PACIFIC ISLANDER
H8DY	115	115	0	CAP ANAMUR
H9BQ	23	23	0	MICRONESIAN INDEPENDENCE
JASQ	35	35	0	HIYOSHI MARU
JBES	70	70	0	YAMASHIN MARU
JBRR	52	52	0	JAPAN TUNA II
JCCX	2	2	0	CHOFU MARU
JCDF	142	142	0	SOYO MARU
JCDT	13	13	0	AMERICA MARU
JCIN	10	10	0	TOKYO MARU
JCOD	44	44	0	SHOYO
JDRD	3	3	0	SHOYU MARU
JFDG	66	66	0	SHUMPU MARU
JGZK	112	112	0	RYOFU MARU
JIOW	23	23	0	ALASKA MARU
JJZC	35	35	0	HAKONE MARU
JPJX	69	69	0	HAKURYU MARU
JPVB	54	54	0	SEIFU MARU
JQVW	7	7	0	***
JSVY	6	6	0	SHIRASE
KDBG	10	10	0	PRESIDENT LINCOLN
KGWU	81	81	0	TH. WASHINGTON
KIYO	19	19	0	EXXON JAMESTOWN
KNBD	5	5	0	DELAWARE II
LOAI	17	17	0	ALMIRANTE IRIZAR
LZTI	2	2	0	***
NBMO	14	14	0	***
NBTM	17	17	0	POLAR STAR
NDWA	1	1	0	MORGENTHAU
NENC	8	8	0	SEALIFT PACIFIC
NFKQ	11	11	0	SEALIFT ARABIAN SEA

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
NGGD	7	7	0	MISSISSIPPI
NHNC	7	7	0	H. LANE
NHTE	23	23	0	ELROD
NHWR	11	11	0	MIDGETT
NIKA	61	61	0	SEALIFT ATLANTIC
NIYJ	1	1	0	INVINCIBLE
NJOR	2	2	0	GALLATIN
NLGF	18	18	0	NORTHLAND
NLVS	25	25	0	RUSH
NOCF	75	75	0	***
NQST	47	47	0	SEALIFT ARCTIC
NRAM	1	1	0	***
NRCB	44	44	0	EAGLE
NRUO	83	83	0	POLAR SEA
NTVT	1	1	0	***
NZSR	4	4	0	J. STRAUSS
NZXF	3	3	0	SAMPSON
OASC	25	25	0	HUMBOLDT
OWEQ	12	12	0	MC KINNEY MAERSK
OXFB	21	21	0	LEXA MAERSK
OXMD	37	37	0	LARS MAERSK
OXYL	4	4	0	BAMSA DAN
OYBG	22	22	0	FALSTRIA
PACM	3	3	0	PACIFIC MISSILE RANGE
PGDF	44	44	0	NEDLLOYD KATWYJK
PGDG	21	21	0	NEDLLOYD KINGSTON
PGDS	28	28	0	NEDLLOYD KYOTO
PGOF	26	26	0	NEDLLOYD KEMBLA
PJYG	45	45	0	OLEANDER
PLAT	169	169	0	PLATFORM
SCOU	1	1	0	TV 243
SCPK	1	1	0	TV 260
SEPI	13	0	13	***
SEXQ	6	6	0	TV 278
SGQJ	51	51	0	ELGAREN
SHIP	279	273	6	***
SHPF	1	1	0	TV 281
SJTQ	1	1	0	TV 171
SKVP	11	11	0	***
SLDN	1	1	0	***
SMZJ	2	2	0	TV105
SMZY	1	1	0	***
UBNZ	68	68	0	SHULEYKIN AKADEMIK
UHQS	18	0	18	ACADEMIC KOROLEV
UJFO	95	90	5	MULTANOVSKIY PROF
UMAY	116	9	107	ACADEMIC SHIRSHOV
UMFW	35	34	1	PROF. ZUBOV
UPUI	93	93	0	PROFESSOR VIZE
UQHM	85	5	80	ABAKANLES
UQYC	9	9	0	***
URYM	6	0	6	RUDOLF SAMOILOVICH
USWN	47	0	47	***
UUQR	9	9	0	MOLCHANOV PAVEL PRO
UUTU	1	1	0	***
UVMJ	6	6	0	VSEVOLOD BERYOZKIN
UVMM	171	152	19	YAKOV GAKKEL
UWEC	18	11	7	KHROMOV PROFESSOR
UZGH	94	92	2	PASSAT
VCBT	31	31	0	CAPE ROGER
VCTF	9	9	0	CAPE BRIER
VC9450	60	60	0	GADUS ATLANTICA
VJBQ	33	33	0	ANRO AUSTRALIA
VJZK	1	1	0	SWAN
VKCK	36	36	0	STUART
VKCN	86	86	0	CANBERRA
VKCV	97	97	0	DERWENT
VKDA	35	35	0	DARWIN
VKLA	58	58	0	ADELAIDE
VKLC	90	90	0	BRISBANE
VKMK	39	39	0	***
VKMN	27	27	0	TEALE
VKMS	142	142	0	COOK
VLNB	88	88	0	TORRENS
VMAP	148	148	0	AUSTRALIAN PROGRESS
VPGE	56	56	0	SWAN REEFER
VP56	75	75	0	AIRCRAFT SQUADRON
VXNB	61	61	0	AIRCRAFT
WCGN	16	16	0	CHEVRON CALIFORNIA
WECB	4	4	0	MELVILLE
WHBA	29	29	0	R.D.CONRAD
WMVC	22	22	0	J.N.COBB
WMVF	96	96	0	ALBATROSS IV
WRA4560	15	15	0	BOLD VENTURE
WRB2237	48	48	0	H. BARBRA
WSE3385	91	91	0	GLORITA
WTDF	97	97	0	T. CROMWELL
WTDK	23	23	0	D.S. JORDAN
WTDM	62	62	0	M.FREEMAN
WTDO	61	54	7	OREGON II
WTEA	82	82	0	DISCOVERER
WTED	99	99	0	CHAPMAN
WTEG	45	45	0	MOUNT MITCHELL
WTEK	1	1	0	DAVIDSON
WTEP	37	34	3	OCEANOGRAPHER
WTER	4	4	0	RESEARCHER
WTES	33	33	0	SURVEYOR
WTEW	50	50	0	WHITING
WTEZ	19	19	0	FERREL
WXBR	5	5	0	CHEVRON MISSISSIPPI
WXQ7334	7	7	0	PETER ANDERSON
WX829	9	9	0	FRED H. MOORE
WYR7512	15	15	0	BALD EAGLE
WYR9891	48	48	0	SEA HAVEN
WYV6568	68	68	0	DEFIENCE
WZE39	21	21	0	MOANA WAVE
Y3CH	10	0	10	PROF. ALBRECHT PENCK
ZCSK	19	19	0	SKEENA
ZCSL	43	43	0	NIMOS
ZCUZ	1	1	0	POYANG
ZM7552	46	46	0	KAHA ROA
3EIX2	28	28	0	PRESIDENTE IBANEZ
3FHI2	139	139	0	MOANA PACIFIC
5MCB	8	8	0	PACMERCHANT
7JFP	61	61	0	DAI 48 SUMIYOSHI MARU
7JOB	13	13	0	SHINKASHU MARU
7JWN	27	27	0	TAKUYO
7KZU	9	9	0	HYUGA MARU
8JNZ	85	85	0	KOFU MARU
9VUU	1	1	0	ANRO ASIA
BATHYS	8188			TOTAL BATHYS REC'D
TESACS	1245			TOTAL TESACS REC'D
TOTALS	9433			TOTAL OF ALL REPORTS

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BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN WAVE HT (M)	MAX WAVE HT (M)	MAX WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
32302	18.0S	085.1W	733	19.9	20.5	1.7	2.4	27/06	11.4	SE	19.4	18/14	1015.7
41001	34.9N	072.9W	742	13.9	19.8	2.5	6.1	26/15	0.0	N			1022.4
41002	32.2N	075.3W	294	16.6	19.9	2.3	5.4	26/09	13.6	SE	29.1	08/08	1024.4
41006	29.3N	077.4W	742	19.0	21.8	2.1	4.2	26/07	12.8	E	31.0	10/00	1023.3
42001	25.9N	089.7W	119	20.2	23.9	1.6	3.4	14/03	13.4	NE	27.0	09/09	1022.2
42002	26.0N	093.5W	247	19.0	22.8	1.8	4.3	13/21	16.1	NE	29.2	13/15	1021.5
42007	30.1N	088.9W	742	9.5	12.7	0.7	1.7	17/10	0.0	N			1023.5
42015	30.1N	088.2W	743	10.4	13.4	0.7	2.0	17/16	12.1	N	24.9	02/14	1024.0
44004	38.5N	070.6W	203	9.3	17.8	2.4	6.0	08/21	14.9	NW	30.5	26/09	1024.6
44005	42.7N	068.3W	742	0.4	4.1	2.0	5.6	05/07	14.4	SW	31.3	06/06	1020.6
44006	36.2N	075.5W	743	4.2	6.6	1.3	3.9	08/11	12.5	N	30.3	14/11	1025.1
44007	43.5N	070.1W	742	-2.3	4.2	1.0	3.4	27/01	13.9	SW	35.0	05/10	1020.1
44008	40.5N	069.5W	723	1.9	5.2				15.8	NW	40.6	26/12	1021.9
44009	38.5N	074.6W	283	0.1	6.7	1.3	4.1	09/00	16.3	NW	38.9	05/09	1027.9
44011	41.1N	066.6W	743	2.4	4.7	2.3	6.7	26/20	12.4	NW	30.8	26/14	1021.5
44012	38.8N	074.6W	687	1.1	5.0	1.0	3.7	09/01	13.2	NW	35.0	05/06	1025.1
44013	42.4N	070.8W	740	-1.8	3.2	0.6	2.8	09/07	13.6	W	32.3	05/08	1021.3
45001	48.0N	087.7W	741	-8.6	2.7	1.6	4.3	12/17	10.0	N	27.2	12/17	1016.5
46001	56.3N	148.3W	744	3.4	4.9	3.3	7.9	22/03	14.5	S	32.1	21/22	1002.6
46002	42.5N	130.4W	744	10.5	11.2	3.9	8.5	11/01	15.4	S	32.3	10/19	1016.1
46003	51.9N	155.9W	744	3.4	3.4	4.0	10.5	21/10	16.2	SW	39.7	20/13	999.1
46004	50.9N	135.9W	743	6.6	8.0	3.8	11.0	24/20	14.6	W	31.0	24/21	1009.3
46005	46.1N	131.0W	743	9.4	9.9	3.9	11.0	15/01	7.9	N	34.4	14/22	1013.2
46006	40.8N	137.6W	743	10.6	11.3	4.0	9.1	13/22	18.4	S	46.2	14/01	1014.5
46010	46.2N	124.2W	719	7.4	9.3	3.0	8.9	14/19	17.7	E	42.4	11/05	1017.9
46011	34.9N	120.9W	246	12.1	12.5	2.5	9.2	18/12	11.0	N	39.2	18/03	1020.4
46012	37.4N	122.7W	742	11.3	11.6	2.4	6.9	18/09	8.8	NW	33.0	18/05	1021.3
46014	39.2N	124.0W	744	10.7	11.4	2.9	7.2	15/19	10.5	SE	33.5	18/01	1020.6
46022	40.7N	124.5W	744	10.2	10.8	3.1	7.2	15/19	13.1	S	34.2	14/21	1020.8
46023	34.3N	120.7W	103	12.1	12.6	2.0	3.0	29/04	8.8	NW	21.4	31/04	1017.4
46025	33.7N	119.1W	737	13.5	13.7	1.4	8.0	18/03	7.4	W	33.0	18/06	1019.1
46026	37.8N	122.7W	469	11.0	10.9	2.3	5.1	18/11	10.8	NW	36.1	18/08	1022.2
46027	41.8N	124.4W	740	9.5	10.3	2.9	6.7	11/11	12.1	SE	33.0	14/21	1020.9
46028	35.8N	121.9W	742	12.2	12.7	2.4	8.0	18/11	9.3	NW	35.8	18/06	1021.2
46035	57.0N	177.7W	728	-0.5	2.3	3.2	10.5	01/13	17.9	N	42.6	01/12	992.5
46039	48.2N	123.4W	735	5.8	7.9	0.6	2.0	29/23	2.6	N	27.2	29/18	1017.8
46040	44.8N	124.3W	744	11.7		3.2	11.7	11/07	12.3	E	38.9	11/06	1018.7
46041	47.4N	124.5W	741	6.8	8.4	2.9	7.9	15/11	13.2	SE	31.1	14/17	1017.4
46042	36.8N	122.4W	708	11.3	11.9	2.6	9.1	18/12	9.7	NW	35.0	18/05	1020.6
51002	17.2N	157.8W	688	24.7	25.4	2.7	4.3	23/06	14.6	E	22.0	26/18	1014.9
51004	17.5N	152.6W	248	24.3	25.2	2.6	3.8	15/16	13.3	E	23.8	07/04	1015.0
51005	20.4N	156.1W	735	23.1	24.6	1.8	3.5	02/05	15.1	NE	29.1	02/04	1016.7
ALSN6	40.5N	073.8W	723	-0.8	4.2				14.1	NW	41.1	05/06	1024.1
BURL1	28.9N	089.4W	742	11.6					15.7	N	34.5	25/07	1023.0
BUZM3	41.4N	071.0W	743	-0.6					16.2	SW	40.1	05/03	1022.3
CARO3	43.3N	124.4W	744	8.2					10.1	S	49.1	11/07	1019.9
CHLV2	36.9N	075.7W	742	3.3	6.0				12.9	N	35.1	14/11	1025.4
CLKN7	34.6N	076.5W	690	6.0					10.6	N	30.0	03/12	1024.0
CSBF1	29.7N	085.4W	744	10.0					5.2	N	21.0	26/00	1024.0
DBLN6	42.5N	079.4W	665	-2.0					14.4	S	44.1	04/18	1020.0
DESW1	47.7N	124.5W	744	6.2					13.2	SE	45.1	14/19	1017.2
DISW3	47.1N	090.7W	670	-10.1					15.5	W	41.1	12/11	1018.6
DPIA1	30.3N	088.1W	744	9.6	10.6				13.1	N	28.3	05/11	1023.8
DSLN7	35.2N	075.3W	743	8.3	14.9				17.8	N	39.1	14/12	1024.1
FBIS1	32.7N	079.9W	742	5.8					7.3	N	28.0	07/15	1024.1
FFIA2	57.3N	133.6W	744	1.7					13.0	N	37.3	28/04	1010.3
FPSN7	33.5N	077.6W	744	10.4	18.5				16.5	N	43.1	08/05	1024.2
GDIL1	29.3N	090.0W	743	10.7	12.1				11.2	N	32.0	13/12	1023.7
GLLN6	43.9N	076.4W	678	-3.3					17.3	S	42.1	13/13	1019.9
IOSN3	43.0N	070.6W	743	-2.4					14.7	W	37.1	14/03	1021.5
LKWF1	26.6N	080.0W	741	19.5	23.0				13.3	E	26.0	21/13	1022.5
MDRM1	44.0N	068.1W	742	-2.2					18.1	NW	42.1	05/10	1020.4
MISM1	43.8N	068.9W	743	-1.9					18.8	SW	46.1	06/01	1021.4
MLRF1	25.0N	080.4W	742	20.8	23.8				15.0	SE	28.7	30/02	1021.3
NWPO3	44.6N	124.1W	743	6.8					12.2	E	54.1	11/06	1018.8
PILM4	48.2N	088.4W	742	-10.4					14.8	N	37.1	04/02	1017.2
PTAC1	39.0N	123.7W	743	9.5					8.6	SE	29.0	18/01	1020.9
PTAT2	27.8N	097.1W	743	11.0					5.0	N	24.0	04/22	1023.2
PTGC1	34.6N	120.7W	713	12.5					12.9	N	51.1	18/10	1019.8
ROAM4	47.9N	089.3W	743	-9.8	2.1				19.2	N	47.1	10/12	1016.8
SAUF1	29.9N	081.3W	741	10.6					9.5	N	25.4	15/15	1024.5
SBIO1	41.6N	082.8W	740	-3.9					15.0	SW	34.1	04/21	1021.5

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BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN WAVE HT (M)	MAX WAVE HT (M)	MAX WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
SGNW3	43.8N	087.7W	611	-8.3					12.2	W	34.1	26/01	1019.0
SISW1	48.3N	122.8W	743	5.5					11.9	SE	38.1	16/03	1017.9
SPGF1	26.7N	079.0W	676	20.0	22.8				9.9	E	24.4	26/01	1022.2
SRST2	29.7N	094.1W	744	8.2					9.1	N	26.0	06/23	1023.6
STDM4	47.2N	087.2W	728	-7.1					19.3	NW	44.1	20/13	1016.6
SVLS1	32.0N	080.7W	742	7.9	10.0				9.5	N	36.0	07/14	1024.9
TPLM2	38.9N	076.4W	738	-0.8	3.4				9.4	NW	32.0	26/11	1024.6
TTIW1	48.4N	124.7W	744	6.2					17.4	E	50.1	03/12	1017.1
VENF1	27.1N	082.5W	742	14.9	16.7				9.2	NE	30.0	25/19	1022.4
WPOW1	47.7N	122.4W	505	5.8					7.7	S	26.3	28/14	1018.5
FEBUARY	1988												
32302	18.0S	085.1W	692	20.7	21.0	1.7	2.5	01/16	10.1	SE	17.5	12/08	1013.7
41001	34.9N	072.9W	695	13.8	19.2	2.5	6.3	16/08	6.3	N	29.6	28/14	1018.2
41002	32.2N	075.3W	695	16.0	19.5	2.1	5.9	13/01	12.9	S	29.5	12/23	1019.6
41006	29.3N	077.4W	694	18.4	20.9	2.0	4.2	13/01	12.3	NW	29.3	28/11	1020.0
42002	26.0N	093.5W	232	19.5	22.1	1.6	5.4	06/15	14.4	SE	36.3	06/09	1019.9
42007	30.1N	088.9W	694	11.2	11.7	0.5	2.0	19/02	1.3	N	15.3	29/02	1021.3
42015	30.1N	088.2W	694	11.6	13.4	0.5	2.3	15/08	10.6	N	28.0	12/08	1021.7
44004	38.5N	070.6W	242	5.5	8.3	2.3	5.0	28/15	14.0	NW	27.4	28/12	1014.4
44005	42.7N	068.3W	694	1.0	3.7	2.2	6.7	12/23	13.9	SW	30.5	12/20	1016.6
44006	36.2N	075.5W	694	5.4	5.9	1.3	3.9	28/16	11.7	N	28.0	16/13	1019.7
44007	43.5N	070.1W	695	-1.0	3.2	1.3	7.3	13/00	13.8	N	40.8	12/20	1015.7
44008	40.5N	069.5W	684	2.6	4.3	1.9	3.8	21/21	16.7	NW	37.9	14/03	1017.3
44009	38.5N	074.6W	100	2.0	4.4	1.3	3.0	28/07	13.0	SW	26.2	28/10	1016.0
44011	41.1N	066.6W	580	2.9	4.0	2.6	7.8	13/05	14.2	W	29.8	14/18	1017.8
44012	38.8N	074.6W	661	2.4	3.8	1.2	3.2	12/06	15.1	NW	35.0	13/03	1019.6
44013	42.4N	070.8W	694	0.1	2.7	0.8	4.7	12/21	14.3	W	34.6	12/11	1016.5
45001	48.0N	087.7W	236	-15.0	1.3	1.0	2.5	07/03	0.0	N			1028.7
46001	56.3N	148.3W	695	3.5	4.6	4.3	8.1	19/05	16.9	S	31.6	28/00	1001.1
46002	42.5N	130.4W	695	9.9	10.7				11.2	S	24.5	12/17	1024.5
46003	51.9N	155.9W	694	3.7	3.2	4.9	12.0	16/18	20.8	SW	41.7	16/16	992.7
46004	50.9N	135.9W	694	6.9	7.5	3.6	7.0	05/14	14.5	SW	27.2	05/05	1017.1
46005	46.1N	131.0W	694	8.7	9.3	3.2	6.9	12/20	0.0	N			1022.6
46006	40.8N	137.6W	694	10.6	11.1	3.1	5.9	04/22	14.1	SW	33.6	04/19	1023.9
46011	34.9N	120.9W	232	13.0	13.0	2.2	3.9	11/09	10.7	N	26.1	29/09	1018.6
46012	37.4N	122.7W	695	11.3	11.4	2.0	4.4	18/11	8.4	NW	25.3	18/10	1021.1
46014	39.2N	124.0W	695	10.4	11.1	2.4	4.4	16/03	0.0	N			1021.9
46022	40.7N	124.5W	694	9.7	10.2	2.5	5.0	13/15	9.5	N	29.1	16/07	1023.9
46023	34.3N	120.7W	695	13.2	13.0	2.3	4.7	19/00	10.7	NW	23.3	10/03	1017.9
46025	33.7N	119.1W	693	14.7	14.4	1.0	2.3	17/16	7.8	NW	28.8	17/10	1017.9
46026	37.8N	122.7W	634	11.8	11.4	1.8	3.3	11/02	9.2	NW	32.4	18/08	1021.1
46027	41.8N	124.4W	693	9.3	10.0	2.3	4.5	10/20	9.0	N	31.1	16/02	1024.5
46028	35.8N	121.9W	694	12.6	12.7	2.1	4.2	19/00	10.3	NW	25.6	18/14	1019.8
46035	57.0N	177.7W	686	-2.1	2.0	3.1	7.4	04/08	19.6	NE	36.3	01/04	996.8
46039	48.2N	123.4W	367	6.2	7.5	0.6	3.1	13/17	8.3	NE	33.0	13/09	1022.4
46041	47.4N	124.5W	695	7.6	8.3	2.6	6.7	13/09	8.3	SE	29.1	13/05	1023.3
46042	36.8N	122.4W	630	11.3	11.6	2.4	5.0	18/15	9.9	NW	23.3	17/00	1019.8
51004	17.5N	152.6W	135	24.2	25.2				14.7	E	23.0	07/19	1015.0
51005	20.4N	156.1W	689	23.4	24.7	1.8	3.0	13/20	15.1	NE	27.2	26/07	1017.1
ALSN6	40.5N	073.8W	679	1.3	3.6				17.0	SW	40.1	12/06	1018.2
BURL1	28.9N	089.4W	695	12.5					12.8	N	33.1	06/15	1021.1
BUZM3	41.4N	071.0W	695	0.7					16.4	SW	40.1	12/10	1017.3
CARO3	43.3N	124.4W	694	8.4					7.0	N	27.0	28/18	1025.2
CHLV2	36.9N	075.7W	694	5.1	5.7	1.2	3.3	19/20	16.3	S	35.1	03/07	1019.7
CLKN7	34.6N	076.5W	694	8.5					11.3	N	31.7	13/01	1019.6
CSBF1	29.7N	085.4W	694	11.5					4.9	N	21.0	15/21	1021.5
DBLN6	42.5N	079.4W	590	-3.4					13.9	SW	40.1	20/22	1016.5
DESW1	47.7N	124.5W	695	7.2					10.5	SE	38.1	13/04	1023.1
DPIA1	30.3N	088.1W	695	11.1	11.7				11.3	N	30.4	06/16	1021.3
DSLN7	35.2N	075.3W	695	9.8	12.7				17.3	N	44.1	15/22	1019.0
FBIS1	32.7N	079.9W	695	8.8					7.0	SW	22.0	07/11	1020.7
FFIA2	57 3N	133.6W	313	0.8					15.2	N	33.9	05/17	1015.0
FPSN7	33.5N	077.6W	695	11.8	16.7				16.5	N	40.1	12/22	1019.8
GDIL1	29.3N	090.0W	673	12.4	13.5				10.4	NE	33.1	06/01	1021.5
GLLN6	43.9N	076.4W	601	-4.5					14.6	W	38.1	06/19	1015.9
IOSN3	43.0N	070.6W	695	-0.7					14.5	W	37.1	12/17	1016.9
LKWF1	26.6N	080.0W	694	18.8	22.3				10.6	NW	25.0	07/15	1019.9
MDRM1	44.0N	068.1W	695	-1.3					17.1	SW	48.1	12/23	1016.3
MISM1	43.8N	068.9W	695	-1.0					17.9	SW	56.1	12/23	1017.3
MLRF1	25.0N	080.4W	695	20.2	23.3				13.2	NE	27.3	07/03	1019.1
MPCL1	29.4N	088.6W	273	15.9	17.1	0.6	2.4	19/01	0.7	N	25.8	18/15	1019.4
NWPO3	44.6N	124.1W	694	8.2					8.0	E	26.0	09/20	1024.4

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BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN WAVE HT (M)	MAX WAVE HT (M)	MAX WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
PILM4	48.2N	088.4W	695	-12.1					14.1	W	34.1	22/10	1016.7
PTAC1	39.0N	123.7W	694	9.5					8.3	N	26.0	16/00	1021.8
PTAT2	27.8N	097.1W	693	12.9					10.9	N	30.0	06/02	1020.7
PTGC1	34.6N	120.7W	522	13.6					11.4	N	33.1	18/11	1018.9
ROAM4	47.9N	089.3W	695	-11.1					16.5	NW	45.1	20/04	1016.4
SAUF1	29.9N	081.3W	695	12.2					9.5	N	28.4	05/12	1021.3
SBIO1	41.6N	082.8W	695	-4.0					14.1	W	38.1	22/19	1017.5
SGNW3	43.8N	087.7W	693	-7.1					12.6	W	34.1	20/12	1018.2
SISW1	48.3N	122.8W	692	6.6					7.6	SE	36.1	13/09	1022.9
SMKF1	24.6N	081.1W	467	19.4	21.8				13.9	N	32.4	21/16	1018.5
SPGF1	26.7N	079.0W	627	19.9	22.7				9.1	E	24.1	21/19	1019.5
SRST2	29.7N	094.1W	694	11.2					9.0	S	24.0	18/12	1021.2
STDM4	47.2N	087.2W	691	-8.4					18.5	NW	45.1	20/07	1015.8
SVLS1	32.0N	080.7W	695	9.8	9.5				0.0	N			1020.9
TPLM2	38.9N	076.4W	694	1.8	2.4				11.5	S	36.1	13/06	1018.5
TTIW1	48.4N	124.7W	694	7.3					14.9	E	44.1	13/07	1022.9
VENF1	27.1N	082.5W	693	14.5	15.3				8.8	N	27.0	13/01	1020.1
WPOW1	47.7N	122.4W	694	7.3					10.3	S	35.0	13/03	1023.6
MARCH		1988											
32302	18.0S	085.1W	741	22.1	22.9	2.1	4.0	18/17	12.6	SE	21.2	29/10	1014.7
41001	34.9N	072.9W	744	14.7	18.6	2.3	6.5	19/19	14.3	S	33.2	19/11	1018.7
41002	32.2N	075.3W	743	17.4	19.1	2.1	5.7	19/11	13.6	NW	34.5	19/08	1020.0
41006	29.3N	077.4W	282	20.1	21.7	1.9	4.9	11/03	12.4	S	29.0	11/02	1019.5
41008	30.7N	081.1W	384	14.7	14.9	0.9	1.7	24/23	5.2	N	16.9	21/05	1022.3
42001	25.9N	089.7W	480	20.8	22.3	1.3	4.1	19/06	12.2	SE	27.3	19/02	1019.3
42002	26.0N	093.5W	290	20.2	22.1	1.4	4.3	18/18	14.4	SE	32.4	18/15	1017.4
42007	30.1N	088.9W	742	15.1	18.6	0.4	1.0	03/21	11.8	E	26.8	19/05	1020.0
42015	30.1N	088.2W	739	15.4	16.7	0.7	2.4	04/02	10.9	SE	24.9	19/08	1019.4
44004	38.5N	070.6W	744	8.7	11.8	2.1	6.4	27/13	14.0	NW	30.5	20/21	1018.0
44005	42.7N	068.3W	504	1.9	3.9	1.9	4.8	21/06	14.1	NW	33.6	12/00	1010.3
44006	36.2N	075.5W	258	7.9	6.8	1.1	2.8	11/10	10.1	S	25.1	11/08	1018.7
44007	43.5N	070.1W	744	1.3	3.0	0.8	2.9	27/12	12.2	NW	33.0	11/21	1014.1
44008	40.5N	069.5W	741	4.0	4.2	1.7	4.2	27/19	15.2	NW	33.2	21/02	1015.9
44009	38.5N	074.6W	725	5.7	5.6	1.0	2.6	27/04	14.7	SW	34.4	05/00	1017.8
44011	41.1N	066.6W	134	3.7	4.1	2.4	4.7	05/18	14.0	NW	24.0	12/00	1010.8
44012	38.8N	074.6W	705	5.5	5.1	0.9	2.7	27/07	13.6	NW	33.0	20/17	1018.9
44013	42.4N	070.8W	741	2.9	3.2	0.5	1.6	15/14	13.5	W	29.9	20/21	1015.1
45002	45.3N	086.4W	055	1.6	1.2	0.5	1.0	30/08	9.8	SW	18.5	30/12	1022.0
45007	42.7N	087.1W	177	3.3	2.1	0.9	2.0	26/20	13.0	NW	23.1	28/20	1015.7
46001	56.3N	148.3W	744	3.4	4.8	3.5	9.5	10/20	16.2	SW	34.9	12/00	1001.1
46002	42.5N	130.4W	741	9.8	10.6				12.0	SW	28.0	23/05	1025.0
46003	51.9N	155.9W	743	2.5	2.9	3.7	10.3	10/02	17.1	W	44.3	03/03	1000.2
46004	50.9N	135.9W	744	6.4	7.1	3.9	8.9	05/01	16.0	SW	32.9	05/22	1013.9
46005	46.1N	131.0W	743	8.6	9.4	3.6	11.0	05/23	9.3	N	32.9	23/09	1021.2
46006	40.8N	137.6W	260	10.7	11.4	3.9	7.2	04/13	17.6	SW	32.7	04/07	1022.1
46010	46.2N	124.2W	437	8.7	9.1	2.7	6.6	22/23	14.4	NW	42.2	23/00	1022.4
46011	34.9N	120.9W	248	12.6	12.8	2.5	4.5	27/15	15.2	NW	31.2	10/00	1018.9
46012	37.4N	122.7W	741	10.9	11.6	2.4	4.7	28/01	11.5	NW	29.1	28/02	1022.1
46013	38.2N	123.3W	391	10.4	10.4	2.5	5.3	24/17	17.7	NW	35.4	27/12	1022.3
46014	39.2N	124.0W	737	10.3	11.0	2.6	5.4	24/03	0.0	N			1023.0
46022	40.7N	124.5W	436	9.9	10.4	2.9	5.6	05/15	11.5	N	27.7	30/09	1024.0
46023	34.3N	120.7W	741	12.9	13.3	2.9	5.1	27/18	15.6	NW	27.2	02/04	1018.1
46025	33.7N	119.1W	741	15.2	15.0	1.2	3.1	02/08	7.7	W	30.7	02/07	1017.2
46026	37.8N	122.7W	742	11.0	11.2	1.9	3.7	05/23	13.0	NW	30.7	28/00	1021.4
46027	41.8N	124.4W	739	9.2	10.1	2.5	6.6	23/21	11.0	N	35.0	31/01	1025.3
46028	35.8N	121.9W	744	12.2	12.6	2.6	4.8	27/20	16.6	NW	32.0	27/11	1020.5
46030	40.4N	124.5W	312	9.8	9.5	3.0	5.7	24/03	12.5	N	31.1	27/12	1024.9
46035	57.0N	177.7W	735	-3.0	1.7	2.7	5.7	15/06	19.2	NE	34.8	29/08	1009.3
46040	44.8N	124.3W	743	8.4		3.0	6.9	06/09	11.9	S	38.5	22/23	1024.0
46041	47.4N	124.5W	744	7.7	9.0	2.9	7.7	06/07	10.6	NW	31.1	22/20	1021.8
46042	36.8N	122.4W	692	11.1	11.6	2.7	5.4	28/05	14.2	SW	27.2	27/07	1020.7
51001	23.4N	162.3W	525	22.4	24.1	2.6	5.0	15/11	12.5	NE	22.5	31/04	1018.3
51005	20.4N	156.1W	734	23.4	24.6	1.8	3.1	31/12	16.4	E	23.3	01/08	1018.5
ALSN6	40.5N	073.8W	732	4.9	4.9				15.4	NW	33.1	25/19	1017.4
BURL1	28.9N	089.4W	744	16.2					13.4	E	29.9	14/07	1018.6
BUZM3	41.4N	071.0W	743	3.3					15.3	W	40.1	21/01	1015.9
CARO3	43.3N	124.4W	741	8.5					10.0	S	33.1	23/08	1025.3
CHLV2	36.9N	075.7W	739	8.0	8.5				14.9	S	32.0	15/13	1019.3
CLKN7	34.6N	076.5W	742	11.8					11.0	S	25.8	10/20	1019.3
CSBF1	29.7N	085.4W	743	15.5					5.9	E	28.0	10/05	1019.8
DBLN6	42.5N	079.4W	682	0.5					10.5	SW	34.1	30/16	1016.8
DESW1	47.7N	124.5W	744	7.6					13.3	SE	50.1	22/20	1021.6

U.S. NDBC Climatological Data cont'd
January, February and March 1988

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
DPIA1	30.3N	088.1W	596	14.9	16.3				12.6	SE	28.3	10/00	1019.3
DSLN7	35.2N	075.3W	742	13.0	16.0				17.1	N	39.1	27/01	1018.8
FBIS1	32.7N	079.9W	741	12.8					7.2	SW	23.0	22/06	1020.5
FFIA2	57.3N	133.6W	722	4.6					12.5	SE	34.6	07/16	1012.0
FPSN7	33.5N	077.6W	743	14.6	15.6				15.5	S	37.1	11/03	1019.5
GDIL1	29.3N	090.0W	742	16.4	17.4				10.8	E	25.6	19/09	1018.6
GLLN6	43.9N	076.4W	655	-1.0					11.7	W	30.0	30/22	1016.0
IOSN3	43.0N	070.6W	744	1.9					13.9	NW	35.1	11/18	1015.3
LKWF1	26.6N	080.0W	743	20.5	22.2				11.5	E	23.0	04/07	1020.3
MDRM1	44.0N	068.1W	742	0.5					17.2	NW	43.1	12/01	1013.5
MISM1	43.8N	068.9W	744	0.7					17.4	NW	45.1	27/12	1015.3
MLRF1	25.0N	080.4W	743	21.5	22.9				14.1	SE	25.1	10/23	1019.4
MPCL1	29.4N	088.6W	740	17.4	18.2	0.8	2.8	03/21	0.0	N			1019.3
NWPO3	44.6N	124.1W	741	8.2					10.7	E	40.1	23/01	1024.4
PILM4	48.2N	088.4W	732	-4.0					14.6	NW	38.1	25/07	1016.3
PTAC1	39.0N	123.7W	744	9.4					10.1	N	37.1	27/10	1022.9
PTAT2	27.8N	097.1W	742	16.2					12.2	SE	32.2	29/22	1017.4
PTGC1	34.6N	120.7W	436	13.4					15.8	N	35.1	28/14	1017.8
ROAM4	47.9N	089.3W	739	-2.9					17.6	N	49.1	12/15	1015.4
SAUF1	29.9N	081.3W	742	15.5					7.7	N	20.6	10/12	1020.8
SBIO1	41.6N	082.8W	743	2.0					12.2	W	33.1	30/11	1016.8
SGNW3	43.8N	087.7W	741	0.6					11.1	NW	29.0	12/11	1016.0
SISW1	48.3N	122.8W	743	7.2					9.5	SE	40.1	22/20	1021.0
SMKF1	24.6N	081.1W	730	21.5	22.1				15.8	E	27.8	15/02	1019.4
SPGF1	26.7N	079.0W	669	21.1	23.2				9.3	E	23.8	19/15	1019.9
SRST2	29.7N	094.1W	497	16.5					10.2	SE	27.6	28/20	1016.1
STDM4	47.2N	087.2W	741	-2.8					18.9	N	42.1	12/11	1015.7
SVLS1	32.0N	080.7W	744	13.4	12.7				13.3	E	33.0	15/04	1020.1
TPLM2	38.9N	076.4W	744	6.4	5.5				11.2	S	28.0	20/17	1017.8
TTIW1	48.4N	124.7W	741	7.3					14.5	NE	49.1	22/21	1021.3
VENF1	27.1N	082.5W	742	17.7	18.5				9.1	NW	28.0	14/21	1019.7
WPOW1	47.7N	122.4W	744	7.7					10.0	S	31.1	06/01	1021.9

Last issue November's table was in error because the wrong tape was pulled.

Here is the corrected table

U. S. NDBC Climatological Data
November 1987

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
32302	18.0S	085.1W	692	18.6	19.3	2.2	3.5	03/14	12.2	SE	19.4	05/02	1016.5
41001	34.9N	072.9W	719	19.2	23.1	2.2	7.2	22/04	11.8	E	31.0	11/19	1020.2
41002	32.2N	075.3W	239	20.9	24.0	2.2	5.5	12/03	14.5	E	31.7	12/03	1020.5
41006	29.3N	077.4W	718	22.7	25.1	2.4	5.0	02/03	15.2	E	27.0	02/02	1019.1
42001	25.9N	089.7W	720	23.1	26.1	1.7	3.3	03/02	14.5	SE	26.5	16/13	1017.6
42002	26.0N	093.5W	239	22.4	24.6	1.7	3.5	16/15	14.5	N	28.4	16/03	1017.9
42003	26.0N	085.9W	238	23.6	25.1	1.6	3.0	03/03	14.6	E	27.5	02/03	1017.1
42007	30.1N	088.9W	718	16.9	17.8	0.8	2.1	16/20	11.6	E	24.2	06/04	1019.0
42015	30.1N	088.2W	717	16.8	16.7	0.8	2.4	17/04	11.9	E	25.3	11/06	1009.4
44004	38.5N	070.6W	301	16.1	22.1	2.1	7.3	12/16	0.0	N	5.4	01/00	1022.1
44005	42.7N	068.3W	719	7.1	8.9	1.9	6.3	12/19	14.1	SW	34.4	12/13	1018.3
44006	36.2N	075.5W	641	13.1	14.2				10.8	S	32.1	12/04	1021.2
44007	43.5N	070.1W	716	5.3	8.4	0.9	3.3	12/13	13.2	SW	36.9	12/11	1018.3
44008	40.5N	069.5W	654	9.1	10.2				16.7	SW	51.9	12/10	1019.2
44009	38.5N	074.6W	714	11.2	12.6	1.3	4.5	12/03	16.3	SW	44.7	21/19	1021.5
44011	41.1N	066.6W	718	9.2	10.1	2.3	6.1	13/02	13.1	SW	29.8	12/18	1018.7
44012	38.8N	074.6W	639	10.6	12.0	1.2	3.9	11/09	16.1	SW	40.8	21/19	1021.5
44013	42.4N	070.8W	680	6.9	8.3	0.8	4.4	12/10	1.6	N	21.4	01/00	1019.0
45001	48.0N	087.7W	719	1.6	4.4	1.1	4.1	19/09	11.4	NW	24.0	17/22	1017.9
45002	45.3N	086.4W	237	6.6	9.1	1.0	2.2	06/03	14.1	N	27.2	05/07	1019.6
45003	45.3N	082.8W	516	4.7	8.0	1.1	3.6	05/16	13.8	NW	29.1	05/15	1017.2
45004	47.6N	086.5W	235	3.3	5.5	1.2	3.4	05/08	13.4	NW	29.1	06/00	1018.4
45005	41.7N	082.4W	112	12.2	10.3	0.4	1.3	05/15	8.4	E	21.4	05/14	1020.0
45006	47.3N	089.9W	213	4.7	6.4	0.7	2.1	05/01	10.7	NW	23.3	05/01	1018.6
45007	42.7N	087.1W	253	8.2	9.1	0.9	2.7	05/15	11.6	S	27.2	05/13	

U.S. NDBC Climatological Data cont'd

November 1987

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
45008	44.3N	082.4W	548	5.8	8.3	1.3	3.3	21/03	15.6	NW	29.1	05/02	1018.0
46001	56.3N	148.3W	713	5.5	7.6	3.3	8.7	17/23	15.6	SW	34.3	17/22	995.1
46002	42.5N	130.4W	718	14.1	15.1	3.7	10.5	30/10	15.1	S	33.7	30/07	1016.6
46003	51.9N	155.9W	718	5.4	6.2	3.4	6.3	25/12	17.4	W	34.7	01/19	1000.2
46004	50.9N	135.9W	716	9.7	11.4	4.0	7.7	11/15	15.0	SW	27.5	17/03	1007.5
46005	46.1N	131.0W	719	13.0	14.5	3.8	7.2	30/17	15.9	SW	32.8	30/15	1013.3
46006	40.8N	137.6W	718	14.3	16.1	3.6	11.7	29/22	17.7	SW	45.0	29/18	1017.1
46010	46.2N	124.2W	717	11.1	11.6	2.8	7.2	30/22	15.2	S	37.9	24/10	1017.7
46011	34.9N	120.9W	239	14.7	15.5	2.5	4.7	10/00	11.1	N	26.5	14/09	1018.3
46012	37.4N	122.7W	716	13.6	14.0	2.3	4.6	21/17	9.2	NW	23.3	14/09	1019.9
46013	38.2N	123.3W	464	13.5	13.5	2.5	4.3	09/11	9.7	NW	26.0	14/16	1019.4
46014	39.2N	124.0W	719	12.9	14.0	2.7	6.5	30/22	9.8	NW	26.9	30/09	1019.7
46016	63.3N	170.3W	222	-6.9					0.0	N			1004.8
46022	40.7N	124.5W	717	12.7	13.3	2.8	5.8	30/20	11.7	S	31.3	30/10	1020.2
46025	33.7N	119.1W	718	16.7	17.6	1.2	2.7	14/12	6.2	W	26.0	14/11	1016.5
46027	41.8N	124.4W	714	12.0	12.8	2.8	6.6	30/20	10.2	SE	29.1	20/12	1020.5
46028	35.8N	121.9W	714	15.0	16.0	2.2	4.1	26/00	11.4	NW	30.3	25/08	1019.3
46035	57.0N	177.7W	715	1.1	4.7	3.1	8.3	14/12	17.2	NE	40.0	14/10	1004.1
46039	48.2N	123.4W	715	8.7	9.2	0.5	1.9	25/02	5.9	N	33.0	13/18	1017.4
46040	44.8N	124.3W	719	10.9	13.0	3.0	7.7	30/20	10.8	S	29.1	24/12	1018.6
46041	47.4N	124.5W	714	10.7	11.8	2.9	7.0	30/22	12.1	SE	35.0	30/17	1017.0
46043	46.9N	124.2W	718	10.1	11.1	2.3	6.3	30/23	0.0	N			1017.7
51001	23.4N	162.3W	006	25.5	26.2	2.2	2.3	01/03	14.6	NE	16.5	01/15	1018.7
51002	17.2N	157.8W	717	26.1	26.9	2.9	5.3	27/10	16.6	E	29.6	28/12	1014.5
51004	17.5N	152.6W	239	25.6	26.3	2.9	4.9	27/16	16.4	NE	24.9	27/22	1014.9
51005	20.4N	156.1W	713	25.1	26.6	2.2	3.9	21/21	18.7	NE	33.0	21/17	1016.7
ALRF1	24.9N	080.6W	718	24.3	25.4				16.2	E	31.0	16/13	1016.0
ALSN6	40.5N	073.8W	714	9.0	10.8				16.4	NW	43.1	22/01	1021.2
BURL1	28.9N	089.4W	485	19.0					16.0	N	29.0	06/05	1018.8
BUZM3	41.4N	071.0W	717	8.0					18.2	SW	44.1	12/06	1020.2
CARO3	43.3N	124.4W	719	11.0					8.6	S	31.0	16/00	1019.8
CHLV2	36.9N	075.7W	598	12.1	14.4				15.5	S	40.1	12/04	1021.3
CLKN7	34.6N	076.5W	704	15.3					9.4	NE	28.0	12/03	1021.5
CSBF1	29.7N	085.4W	719	17.1					5.4	NE	21.0	11/01	1019.4
DBLN6	42.5N	079.4W	661	6.8					14.4	SW	46.1	18/13	1019.2
DESW1	47.7N	124.5W	719	10.2					14.1	SE	45.1	24/07	1016.9
DISW3	47.1N	090.7W	718	3.3					12.6	NE	38.1	19/07	1018.0
DPIA1	30.3N	088.1W	719	16.4	16.9				13.1	E	29.9	06/07	1019.4
DSLN7	35.2N	075.3W	719	17.2	20.4				16.0	NW	42.1	12/03	1020.9
FBIS1	32.7N	079.9W	719	15.3					7.6	NE	23.0	28/04	1021.0
FFIA2	57.3N	133.6W	718	6.0					14.1	SE	40.1	02/10	1005.4
FPSN7	33.5N	077.6W	717	18.7					16.0	SE	38.1	12/01	1020.6
GDIL1	29.3N	090.0W	719	17.6	18.3				11.0	NE	30.0	06/05	1019.1
GLLN6	43.9N	076.4W	682	5.2					14.3	NE	41.1	06/01	1019.0
IOSN3	43.0N	070.6W	717	5.8					14.5	W	35.1	06/09	1019.6
LKWF1	26.6N	080.0W	718	23.5	25.0				13.7	E	30.0	03/02	1017.5
MDRM1	44.0N	068.1W	719	4.9					17.7	NW	43.1	12/19	1018.8
MISM1	43.8N	068.9W	719	5.0					18.1	SW	44.1	12/16	1019.4
NWPO3	44.6N	124.1W	719	10.3					9.3	E	34.1	24/12	1018.7
PILM4	48.2N	088.4W	718	1.3					13.4	NW	38.1	19/08	1018.1
PTAC1	39.0N	123.7W	718	11.7					8.6	N	26.0	25/01	1019.9
PTAT2	27.8N	097.1W	718	18.7					11.0	SE	26.0	19/10	1018.7
PTGC1	34.6N	120.7W	661	14.4					13.4	N	36.1	14/09	1017.9
ROAM4	47.9N	089.3W	719	2.1	5.8				15.4	N	42.1	19/04	1017.4
SAUF1	29.9N	081.3W	719	18.6					9.3	N	26.4	06/13	1020.1
SBIO1	41.6N	082.8W	717	6.8					14.1	SW	33.1	06/02	1019.0
SGNW3	43.8N	087.7W	715	5.1	6.1				11.1	NW	24.0	17/09	1018.3
SISW1	48.3N	122.8W	719	9.0					10.0	SE	41.1	24/10	1016.3
SPGF1	26.7N	079.0W	683	23.3	25.2				10.8	E	30.3	02/04	1017.2
SRST2	29.7N	094.1W	719	15.7					8.3	SE	28.0	16/15	1019.2
STDM4	47.2N	087.2W	716	2.7					17.3	N	39.1	05/23	1017.6
SVLS1	32.0N	080.7W	719	16.8	18.0				14.5	NE	36.1	06/11	1020.6
TPLM2	38.9N	076.4W	719	9.8	10.8				11.9	S	35.1	21/15	1020.9
TTIW1	48.4N	124.7W	718	9.8					15.0	E	43.1	24/04	1016.7
VENF1	27.1N	082.5W	715	20.2	21.1				8.7	NE	26.0	11/17	1017.5
WPOW1	47.7N	122.4W	718	9.7					7.5	S	27.0	24/19	1017.9

Selected Gale and Wave Observations

January, February and March 1988

VESSEL	SHIP CALL	DATE	POSITION LAT. DEG.	POSITION LONG. DEG.	TIME GMT	WIND DIR. 10 DEG.	WIND SPEED KTS.	VSBY	PRES WX. CODE	PRESSURE MBS.	TEMP DEG C. AIR	TEMP DEG C. SEA	SEA WAVES PD. SEC	SEA WAVES HGT. FT.	SWELL WAVES DIR	SWELL WAVES PD. SEC	SWELL WAVES HGT. FT.
	PACIFIC	JAN.															
TOKYO RAINBOW	H3DB	1	50.9 N	172.6 E	00	15	M 65	1 NM	99	0973.7	0.1	1.0	3	10	14	8	31
LEDA MAERSK	OULU	1	49.4 N	162.1 E	00	28	M 55	2 NM		0991.1			13	29.5			
ORIENTAL EXECUTIVE	D5AN	6	45.1 N	179.5 E	00	26	M 57	.25 NM	90	0983.5	3.0	5.0	10	31	25	12	32.5
KUSAN	HOMH	7	45.8 N	168.9 W	00	18	M 57	.5 NM		0976.0	3.0	3.0	11	28	18	12	32.5
PRESIDENT F. ROOSEVELT	KRJF	7	40.5 N	169.5 W	00	29	M 49	2 NM	93	1001.5	5.6	8.3	9	29.5	29	14	59
B.T. ALASKA	WFQE	9	48.7 N	133.5 W	20	25	M 70	.5 NM	07	0986.6	6.1	8.3	13	34.5	23	15	34.5
SANKO CORAL	ELDO2	10	43.8 N	155.9 E	06	27	M 55	1 NM	74	0986.0		5.0	6	14.5	27	15	29.5
MOBIL ARCTIC	KSPY	12	53.2 N	137.8 W	18	13	70	2 NM	65	0970.0	6.7	5.6	4	8	13	10	29.5
SANSINENA II	WSIN	12	46.8 N	131.3 W	18	18	45	2 NM	81	0993.5	10.0	9.4	2	19.5	17	14	32.5
MOBIL ARCTIC	KSPY	13	53.0 N	137.6 W	00	16	70	2 NM	65	0976.0	6.7	6.7	4	10	13	10	32.5
USCGC STORIS (WMEC 38)	NRUC	13	57.3 N	145.1 W	00	09	M 52	2 NM	07	0976.5	4.4	5.0	4	14.5	09	7	29.5
SEALAND TRADER	KIRH	13	38.6 N	169.0 W	06	26	48			0985.0	7.8	12.2	5	10	27	11	34.5
MOBIL ARCTIC	KSPY	13	51.1 N	135.3 W	18	13	60	2 NM	64	0975.8	7.2	6.1	5	10	13	13	29.5
EXXON BOSTON	WHML	14	45.5 N	128.5 W	23	25	M 46	5 NM	89	0997.6	11.3	12.8	7	16.5	24	15	29.5
MOBIL ARCTIC	KSPY	15	47.4 N	131.8 W	00	24	70	2 NM	65	0981.0	10.0	7.8	5	13	24	10	39
PRESIDENT WASHINGTON	WHRN	18	36.7 N	129.0 W	00	32	45	10 NM	02	1017.2	15.6	13.9	10	19.5	33	16	31
PRESIDENT ARTHUR	WGLA	20	42.4 N	146.3 W	18	17	M 45	5 NM		1007.0	8.9	6.1	3	11.5	17	7	29.5
MARIF	DUNP	23	43.9 N	148.9 W	20	23	M 65	2 NM	07	0988.0	8.0	13.0	10	16.5	17	24	36
SEALAND EXPLORER	WGJF	30	35.5 N	165.0 E	12	30	M 55	5 NM	82		11.0		6	19.5	21	8	29.5
	ATLANTIC	JAN.															
RAINBOW HOPE	KNDB	1	60.9 N	29.8 W	15	05	55	5 NM	15	0968.1	5.6	6.1	11	44	05	11	44
MORMACSKY	WMBQ	6	47.0 N	54.4 W	06	24	60	200 YD	90	0989.1		0.6	12	29.5	24	12	37.5
SEALAND EXPRESS	KGJD	7	39.6 N	58.7 W	00	27	M 45	2 NM	80	1010.5	5.0		8	13	27	10	31
SEALAND ADVENTURER	KSLJ	9	47.6 N	15.5 W	00	22	48	1 NM	60	1003.5	13.0	14.0	7	16.5	22	12	32.5
DELAWARE BAY	WMLG	9	47.1 N	24.5 W	00	25	M 50	10 NM	15	1003.6	8.9		9	29.5			
GOLAR PETROSUN	5MGL	25	47.5 N	07.5 W	12	25	50			0987.5	10.0	15.0	9	29.5			
DELAWARE BAY	WMLG	30	47.1 N	13.7 W	00	31	M 50	5 NM	15	1004.2	7.7		10	32.5	34	8	24.5
	PACIFIC	FEB.															
HOEGH DYKE	ZHEM7	4	35.7 N	145.6 E	00	32	55	2 NM	26	1012.0	6.5	18.0	10	34.5	32	7	29.5
GLACIER BAY	KACF	4	59.3 N	145.8 W	12	09	45			1013.0	2.5	5.6	4	13	06	6	29.5
PRESIDENT MONROE	WNRD	5	38.2 N	158.0 W	06	21	M 46	5 NM		0993.1	11.1	10.0	7	19.5	16	9	34.5
SATURN DIAMOND	3EWQ	14	38.2 N	176.0 E	00	23	M 50	1 NM	18	0983.0	11.0	14.0	11	23	23	11	47.5
FRANCIS SINCERE NO. 6	5MCN	14	36.0 N	174.0 E	00	25	M 54			0991.5	9.8	13.0	15	34.5	26	18	29.5
SEA DIAMOND	3FJR2	17	47.8 N	163.8 W	18	20	M 50	2 NM	21	0976.0	7.0	5.0	15	31	18	15	31
USCGC YOCONA (WMEC 168)	NNHB	22	51.8 N	178.5 W	06	01	M 55	.25 NM	80	0970.1	1.7	4.4	8	32.5	02	8	11.5
PRESIDENT JOHNSON	WVHS	25	54.8 N	157.7 W	12	33	M 50	5 NM		0975.5	1.7	4.4	4	14.5	27	7	29.5
	ATLANTIC	FEB.															
RAINBOW HOPE	KNDB	1	55.8 N	37.8 W	06	29	45	5 NM	25	1000.0			3	14.5	29	7	29.5
STAR GRAN	3EWX4	4	44.2 N	07.4 W	14	23	M 52	2 NM		1003.0	13.0	12.0	10	36	23	11	39
CHELSEA	KNCX	7	53.1 N	34.3 W	12	23	46	10 NM		1001.0	3.3	6.1	6	14.5	23	14	32.5
DELAWARE BAY	WMLG	9	46.4 N	12.8 W	00	33	M 50	5 NM	03	1011.2	12.5	10.0	10	29.5			
JALISCO	XCBR	9	47.3 N	15.1 W	06	28	M 45	2 NM	25	1014.5	7.0		9	24.5	22	10	29.5
SEALAND ECONOMY	WNDJ	9	47.8 N	08.5 W	12	27	55	2 NM	16	1009.0	6.7	11.7	6	19.5	27	14	44
ADABELLE LYKES	WPFZ	10	49.0 N	06.2 W	18	27	45	5 NM	81	1005.0	10.0	9.0	5	8	28	11	29.5
DELAWARE BAY	WMLG	12	43.7 N	43.0 W	18	32	M 50	5 NM	26	1024.0	1.0		10	16.5	32	11	32.5
MORMACSUN	WMBK	17	42.2 N	59.2 W	06	22	45	2 NM		1003.0	13.0	16.0	0	14.5	22	10	29.5
RAINBOW HOPE	KNDB	17	45.7 N	52.7 W	21	26	52			1003.7		0.6	5	14.5	25	9	37.5
	PACIFIC	MAR.															
POLAR ALASKA	5LEU	4	43.7 N	150.7 E	06	33	M 50	5 NM		0990.0	0.0	0.0	6	29.5	33	6	29.5
KEYSTONE CANYON	KSFK	5	51.7 N	134.4 W	00	23	M 48	5 NM	16	0991.5	7.2	7.8	6	19.5	23	20	41
MAERSK TACOMA	FNXB	5	46.6 N	137.3 W	18	27	M 57			1004.8	5.7	7.6	11	42.5			
MAERSK TACOMA	FNXB	8	53.3 N	158.9 W	00	30	M 58	2 NM	26	0997.0	- 1.5	3.3	8	29.5			
USCGC RUSH (WHEC 723)	NLVS	9	53.1 N	164.9 W	12	04	M 60	< 50 YD		0966.5	0.6	3.9			05	9	29.5
REGINA MAERSK	OXGR	9	42.6 N	151.9 W	12	19	50	1 NM	81	0997.8	10.0		8	29.5			
USCGC RUSH (WHEC 723)	NLVS	9	53.1 N	164.7 W	18	03	M 54	.5 NM	45	0957.3	0.6	3.9	4	19.5	03	8	39
REGINA MAERSK	OXGR	9	42.3 N	149.1 W	18	18	45	1 NM	81	1000.0	11.2		12	29.5			
GLORY FIELD	3EGR5	10	52.4 N	150.9 W	12	18	M 48	2 NM	58	0984.5	6.5		7	14.5	17	12	29.5
EVER LEVEL	BKHJ	13	45.1 N	160.2 W	18	36	M 47	1 NM	61	1009.5	2.5	5.0	16	29.5	36	16	28
MAERSK WIND	S6BI	14	50.0 N	155.4 W	00	02	M 50	2 NM		1012.0	3.0	4.0	7	8	02	22	29.5
MAERSK WIND	S6BI	14	49.8 N	154.8 W	06	02	M 52	1 NM	62	1003.0	3.0	4.0	6	10	02	18	31
FRANCIS SINCERE NO. 6	5MCN	17	47.5 N	154.1 E	00	26	M 49	2 NM	28	0987.0	- 2.0	1.0	16	31	26	19	36
HANJIN KEELUNG	3EDA5	19	10.4 N	87.2 W	13	36	M 50	2 NM		1007.0	25.0	25.0	8	23	35	9	29.5
BROOKLYN	KGDB	23	46.7 N	132.1 W	12	29	M 45	5 NM		1010.3	7.2	6.1	7	24.5	28	15	32.5
GUANAJUATO	HPRR	27	37.7 N	162.3 E	12	30	45	2 NM	80	0994.2	6.8	15.0	6	28	31	10	29.5
YOUNG SPROUT	3EMQ3	28	40.3 N	169.4 E	00	26	M 66			0988.0	6.5	18.0	10	13	25	18	39
	ATLANTIC	MAR.															
OBERON	S6DY	9	43.8 N	57.2 W	06	36	M 45	50 YD	45	0993.0	- 4.0	4.0	8	44	36	8	44
CHESAPEAKE BAY	WMLH	9	37.7 N	51.1 W	18	33	M 48	2 NM	82		11.1	13.0	6	16.5	34	23	36
MORMACSUN	WMBK	10	39.1 N	43.4 W	18	26	45	5 NM		0993.0	13.3	15.5	7	14.5	26	12	32.5
ARGONAUT	KFDV	12	40.5 N	59.8 W	12	28	45	10 NM		1009.0	6.1	18.3	4	16.5	27	10	32.5

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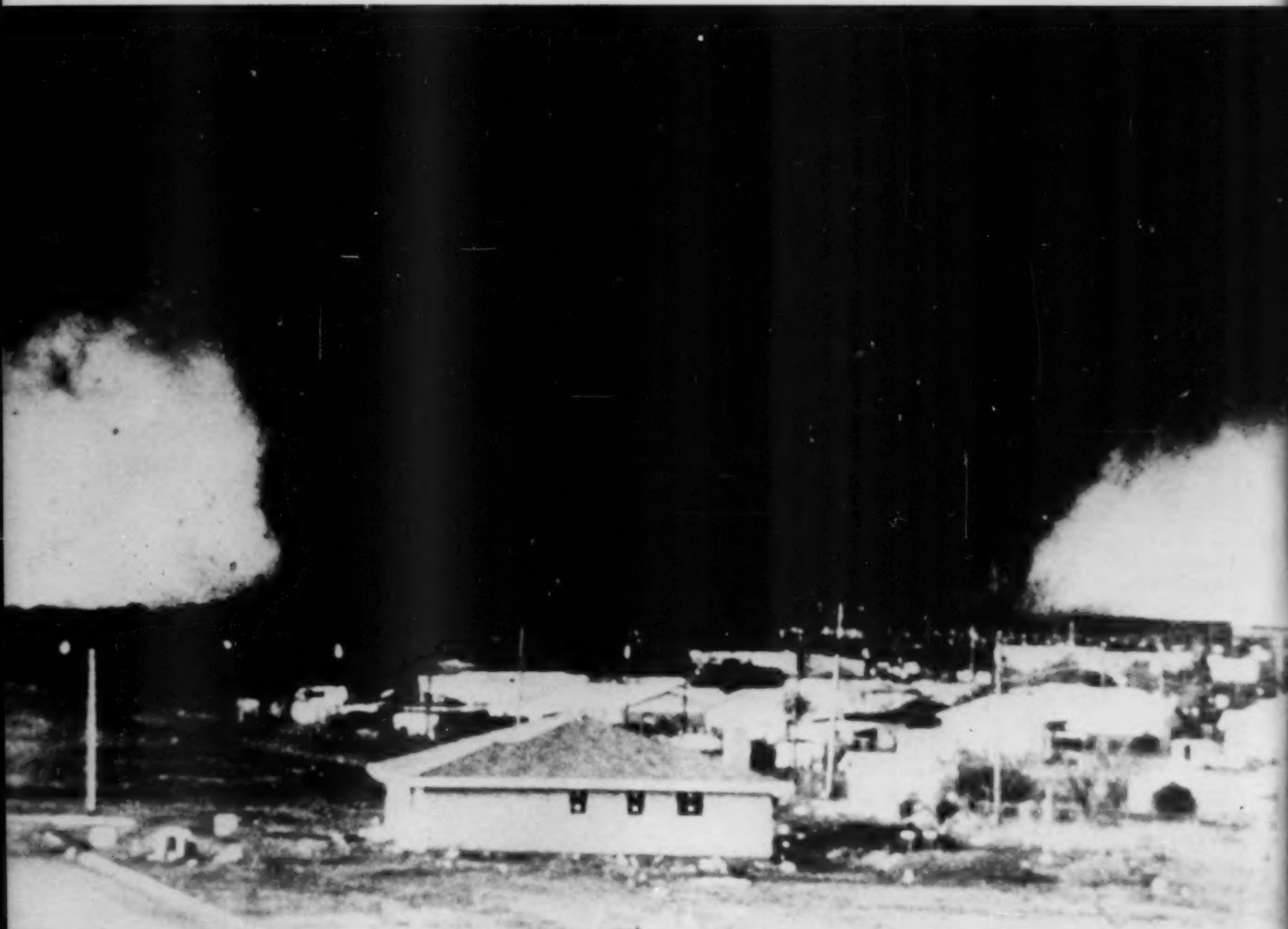

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